APNEA **SURVIVAL**

INSTRUCTOR NOTES

PART 1

THE SURF APNEA COURSE

1. Introduction.

1.1 What's in the course.

The aim of the Apnea Survival - Surf Apnea course is to impart the knowledge and understandings necessary for participants to improve their breath holding and stress management during unexpected and intense aquatic immersion events.

The course focuses on

- Cellular respiration
- Physiology and Psychophysiology of breathing and breath holding
- Increasing breath hold duration
- How to take a last breath
- Relaxation and focus techniques
- Stress and Fear management
- Breathing and breath hold training drills

These notes are an accompaniment to the Surf Apnea Powerpoint presentation and support the topics discussed in the presentation.

1.2 What to expect.

As a result of participating in the Apnea Survival - Surf Apnea course can expect to:

- Be holding your breath. As the word Apnea means "cessation of breathing" or to "pause breathing" and breathing holding is simply pausing your breathing at the
- Have longer and less stressful breath holds
- Develop an understanding of the breath hold journey
- Have more skilful breathing
- An improved response to intense situations
- Enhanced decision making when under stress and most of all you will develop a much
- **Greater self awareness and self control**

Note : There is no assessment for the Introduction section.

Safety considerations when breath holding

1. The buddy system

When training in water always train with a competent buddy and always use a pre rehearsed buddy system that both you and your buddy are familiar with. The buddy system is a safety system that requires a person to remain above the water and / or have the breath holder under direct observation throughout the entire breath hold. The job of the buddy is to monitor the breath holder's behaviour and respond to any circumstances that may place the breath holder in danger.

Safety points to consider when training in water.

1. Never train in water alone.
2. Always training with a competent buddy and use a buddy system
3. Training buddies must both know each other's limits and abilities, practice rescue procedures such as black out, LMC and recovering a breath holder to the surface from the bottom of the pool and what to do at the surface and how to manage an emergency response.
4. Keep all training intensity to a maximum of 70% of your maximum perceived rate of exertion.
5. Use only clear and untinted, non-fogging goggles or masks that always provides
6. unobstructed observation of the breath holder's eyes.
7. Due to the very fast onset of hypoxia associated with exhale breath holds do not perform any exhale breath holds in water-based environments (these are best performed using land-based drills).
8. Plan every breath hold / training session (plan the breath hold and stick to the plan when breath holding).
9. Breath holder and buddy must discuss the particulars of the training / session plan prior to any breath holds being conducted. For example. Types of and times for safety checks and how various signals ('OK' / Not OK) will be communicated.
10. The buddy should remain at the surface or in a position that allows them to have direct observation of the breath holder during the breath hold and be prepared to render immediate assistance if required.
11. The buddy must maintain observation of the breath holder during the entire breath hold and during the recovery periods.
12. During long dynamic swims consider following your breath holder using a snorkel and swimming above them or use an outside lane and walk up and down the pool with the swimmer. This enables direct observation and an immediate response.
13. Watch for signs of loss of consciousness and loss of motor control (LCM). E.g. bubbles - sudden air loss, change in stroke rate, sinking etc. Increases in stroke speed or changes in swimming technique during dynamic efforts may be an indicator of increases in stress due and hypoxia. *Note - If any of following are observed: tremors, loss of motor control, loss of consciousness, sudden air loss (including trickling bubbles or air), and /or failure to react or respond to signals make immediate physical contact with the breath holder, terminate the breath hold and assist them to the surface.* Failure of the breath holder to react or respond to signals during static holds may indicate the breath holder has become hypoxic,

disorientated, or switched off their consciousness. If two consecutive OK requests have failed to solicit a response from the breath holder terminate the breath hold immediately.

14. If black out or loss of motor control occur withdraw the person from training immediately and have them seek medical attention from a medical practitioner who is trained to conduct diving assessments before returning to training.

A few notes on the buddy system. The following article was written by Julien Borde – a professional AIDA freediving instructor and the owner of Pranayama Freediving and Yoga in Playa del Carmen, Mexico. Although it references freediving it is very pertinent to any form of water-based breath hold training.

> *"As in scuba diving the buddy system is very important in freediving. It is a diver's main method of ensuring safety on dives. The buddy system not only reduces the risks of freediving but increases a diver's comfort and enables one diver to control the buoy while the other is underwater. Here are three reasons why using the buddy system is important. One of the most important pieces of advice for freedivers is to never freedive alone!*
>
> *The buddy system only increases diver safety if the buddy knows what to do in the case of an emergency. Here are several safety considerations for a freediving buddy. A freediving buddy should be a certified freediver with enough basic safety knowledge to assist the diver efficiently in an emergency. The freediving buddy should supervise every dive that their companion makes.*
>
> *A freediving buddy should be familiar with and adept at all the rescue techniques. This requires that the buddy not only be certified but that the buddy team practices the rescue skills periodically. Practicing rescue skills during a freediving session only takes a few minutes but makes a rescue exponentially more efficient in the unlikely event of an emergency. Monitoring a diver for problems does not stop when the team reaches the surface. In fact, most losses of motor control (LMC) and black outs will happen at the surface. The buddy needs to keep constant eye contact on the diver until he is sure that the freediver has caught his breath properly and is able to communicate that he feels well.*
>
> *Communication between buddies is also an important aspect of safety. A diver should communicate his dive plan and dive time. Communicating the dive plan allows the buddy to know what to expect of the diver. It is also a good idea to decide on an emergency signal with your buddy so that he knows when you want him to help you swim back to the surface. Communication is equally important on static and dynamic apnea dives, even if the buddy stays at the surface. A buddy will be much more efficient if they know what to expect.*
>
> *Comfort - A training buddy makes the preparation and execution of a breath hold as smooth as possible. A buddy can oversee timing during the preparation of a breath hold and can also track times etc. A good freediving buddy can also make sure that everything stays quiet and calm around the dive site so that the freediver can concentrate. He can ensure that there are no scuba divers hanging on the freediving line and no people jumping around or yelling close to the diver.*
>
> *During static dives the buddy can assume a coaching role. At the end of a static dive, everything becomes complicated for the diver, so the buddy can talk to the diver to help him to relax and handle more contractions to extend the length of his dive. The take-home message about the buddy system and freediving. Never dive alone!"*

Blackout

2. Shallow Water Black Out (SWBO)

Although SWBO has become a generic term for people blacking out anywhere in the water column during a variety of circumstances, its more correctly defined as, a loss of consciousness caused by cerebral hypoxia towards the end of a breath hold in water typically shallower than five meters deep. SWBO only occurs where all phases of the breath hold have taken place in shallow water (5 meters depth or less). Nor is depressurisation a factor with SWBO and the event typically involves static or dynamic apnea distance breath holders (usually in a swimming pool).

A primary mechanism for SWBO is hypocapnia followed by cerebral hypoxia (reduced CO2 in the blood and reduced O2 in the brain). Hypocapnia can cause significant delays with experiencing any feelings of air hunger (needing to breathe) and is often brought about by hyperventilation prior to the breath hold. During any black out event, the breath holder may not necessarily experience a need to breathe and may have no other obvious condition as a trigger preceding the actual black out.

Many blackouts underwater have been associated with the practice of hyperventilation. Survivors of shallow water blackout often report using hyperventilation techniques to increase their bottom time. Hyperventilation is sometimes used in the mistaken belief it will increase oxygen (O2) saturation and make the breath hold more relaxing. Under normal circumstances the breathing rate dictated by the body alone already leads to 98-99% O2 saturation of the arterial blood and the effect of over-breathing on the oxygen intake is very minor.

Blacking out in water results in drowning unless the breath holder is rescue immediately. Blacking or greying out near the end of a limit pushing breath hold is not uncommon during competition. However. Should be avoided completely during training or at a recreational level. The most current thinking on the topic has identified blacking out especially underwater is not as benign as once thought. It results in a lingering Central Nervous System trauma which can predispose the breath holder to greater risk of future black out events, create performance barriers and training setbacks. This is due to a phenomenon known as *fear perceptive memory*, whereby the body attempts to prevent the traumatised person from revisiting the place (mentally or physically) where the original injury occurred.

3. Deep Water Black Out (DWBO)

Deep water blackout on the other hand is precipitated by depressurisation on ascent from depth (review diffusion theory – Grahams law). The mechanism for deep water blackout differs from that for shallow water blackouts and does not necessarily follow hyperventilation but hyperventilation will exacerbate it.

DWBO occurs as the surface is approached following a breath hold dive of over ten meters. It typically involves the practice of deep diving usually in open water. The immediate cause of DWBO is the rapid drop in the partial pressure of O2 in the lungs on ascent and the vital organs being depleted of O2 due to air space volume increasing as pressure on the body decreases (drawing O2 away from the vital organs).

For most people the first sign of low levels of O2 is a http://en.wikipedia.org/wiki/Greyout_(medical)grey out or unconsciousness (black out). These occur with no reliable bodily sensation or warning.   A grey out is a transient loss of vision characterised by a dimming of light and colour and sometimes a loss of peripheral vision. It can be a precursor to blackout. If left unsupervised a black out breath holder in water will drown quietly without alerting anyone.

4. Surface blackout

Surface blackout occurs when a breath holder with low levels of circulating O2 has surfaced from a challenging breath hold and has started breathing. The breath holder can black out before any inhaled O2 has time to circulate and reach the brain (up to 30 seconds). This process can be exacerbated by the reduction in internal lung pressure (Eg. exhaling forcefully upon surfacing) resulting in a reduction in partial pressure of O2 in the lungs and loss of diffusion which can cause a drop in cerebral O2 saturation and thus blackout.

5. Avoiding a black out

Black Out can be avoided by ensuring that carbon dioxide levels in the body are maintained prior to a breath hold and that appropriate safety measures are in place. This can be achieved by the following:

1. Taking time prior to the breath hold to relax and allow blood O2 and CO2 levels to reach their natural equilibrium.
2. Prior to the breath hold use your normal relaxed breathing rate and depth and allow your body to dictate the rate of breathing to ensure CO2 levels are properly calibrated.
3. If excited or anxious about a breath hold spend additional time calming and relaxing.
4. Use relaxation techniques to extend your relaxation time which will extend your breath hold time.
5. Develop your breath hold abilities gradually and progressively.
6. Get yourself and your b=training buddy formerly trained (certified) in the techniques you are using.
7. Never train alone. Always train with a competent buddy.
8. Always have one person observing from the surface whilst the other is diving.
9. Never push limits beyond 7/10.

6. Response to shallow or deep-water blackout.

1. Recovery the breath holder to the surface.
2. Roll the diver face up using the push pull method (Closest hand pushes down on closest shoulder. Other hand reaches across diver and pulls furthest away shoulder toward rescuer. The breath holder will roll toward the rescuer and be rotated onto their back.
3. Keep the diver afloat face up by supporting them with a knee into their glutes or swimming with them to keep them afloat.
4. Remove the breath holder's mask / goggles (exposing fascial sensors and airways).
5. Repeatedly call the breath holders name and instruct them to breathe. Eg, "Breathe - *Name of breath holder* - breathe!"
6. Simultaneously blow air across their cheeks (this helps stimulate breathing).
7. If the diver does respond and regains consciousness help the diver exit the water. Give O2 therapy if available, maintain continuous observation and seek medical assistance.
8. If the diver does not respond within 45 seconds begin rescue breaths and rescue procedures as per whatever CPR training you have received.
9. Call out for / seek assistance.

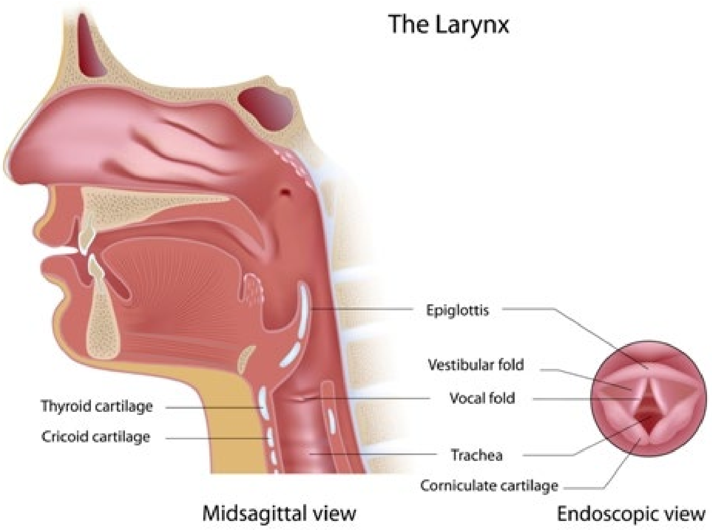
10. Remove breath holder from the water ASAP.
11. If breath holder is not breathing once removed from water commence CPR immediately, send for help and call emergency medical services (as per whatever CPR training you have received).
12. NOTE: Be aware of the "Laryngospasm" – This is when the epiglottis locks shut and seals off the throat to prevent water inflow to lower airways and lungs. The release of this spasm is triggered by rising levels of CO_2 and may take 45-60 seconds at the surface to occur. The breath holder cannot breathe until the spasm has relaxed.
13. The breath holder should not train again until cleared by a medical practitioner qualified in diving examinations (a four-week period before returning to breath holding is the general rule following any loss of consciousness).
14. Practice and be prepared to respond to medical emergencies and undertake training in First Aid, CPR / Advanced resuscitation / O_2 provider
15. Ensure you or your training venue has functioning emergency life support equipment such as Oxygen, AED (defibrillator), etc. Know where it is located prior to training at the facility.

NOTE: <u>ALWAYS</u> seek medical advice following any black out event. Drowning can occur hours after the event if water has entered the lungs.

7. Laryngospasm

Laryngospasm refers to a sudden spasm of the vocal chords. The spasm can be a symptom of underlying conditions including anxiety, stress or the *entry of water into the larynx or trachea* (windpipe). In an aquatic environment laryngospasm can occur when a person is negotiating waves or turbulent waters like rapids. It typically happens when a person breaks the surface and attempts to take a breath at the same time water unexpectedly enters the upper airway (trachea or larynx). At this moment an involuntary reaction occurs during which the vocal chords close rapidly in an effort seal off the wind pipe and prevent any ingress of water to the lungs.

When experiencing a laryngospasm people report feelings of choking and an inability to breath. The spasm can occur in both conscious and unconscious people and is not uncommon in submerged blackout victims. Although quite a stressful (when experienced conscious) the spasms generally last only 5-10 seconds. Laryngospasm can be treated by holding your breath for around 10 seconds allowing CO_2 levels to rise. The subsequent rise in CO_2 is one of the things that can trigger the release of the spasm. To recover from the spasm breathe in and out slowly through your nose keeping the mouth closed or if too challenging inhale through the nose and gently exhale through pursed lips.



8. Loss of motor control (LMC) / Samba

Loss of motor control (LMC) AKA Samba is a series of muscle twitches caused by low O2 levels in the body. LMC can be a minor tremble and brief event or violent convulsions progressing to unconsciousness.

Indicators of LMC include:

1. Trembling
2. Convulsions
3. Confusion
4. Difficulty breathing
5. Lack of responsiveness,
6. Loss of bladder control and
7. Cyanosis (blue lips).
8. Saucepan eyes

Avoid LMC in training by extending breath hold times gradually and never beyond 70% of your maximum ability. Do not push limits prematurely. It takes time for your body to adjust and adapt.

9. Response to loss of motor control (LMC)

1. Hold the head / face / airways of a breath holder clear of the water.
2. Remove mask / goggles.
3. Keep the Breath holders airway clear.
4. Talk to the breath holder in a clear assertive voice, 'Breathe……. Breathe ….. Breathe…, etc' as you would during a black out.
5. Provide a visual cue by clearly demonstrating how you wish them to breath.
6. Look into their eyes acknowledge them and direct them to follow your breathing. Like me… Breathe like me….do this inhale… exhale….
7. Encourage big inhales with short, relaxed exhales (aids diffusion).

8. Provide verbal and visual reassurance.
9. After recovery the diver should discontinue diving and seek medical attention as per blackout aftercare.

Lesson One – Breathing.

1.1 Why we breathe.

"Why do we breathe?"

- Humans are aerobic beings. They rely on aerobic respiration to survive.
- Oxygen (O2) is required for aerobic respiration (production of energy).
- Metabolic by-products such as Carbon (C) in the form of carbon dioxide – CO_2 need to be removed from the body.

Respiration is the movement of gas across a membrane. For example. Gas exchange in the lungs is referred to as external respiration. A thin membrane called the respiratory membrane allows gas to cross and separates air within the alveoli from blood within pulmonary capillaries.

After a couple of minutes of activity your body's cells use the O2 you've inhaled when to get energy from the food you eat. This process is called *aerobic respiration.* During *aerobic respiration* cells use O2 to break down sugar (from the food we ve consumed) initiating the multi stage aerobic process.

The breaking down of the sugar produces the energy we need to contract muscles which enables us to do the things we want our bodies to do. Carbon dioxide (CO2) is produced as a result of aerobic respiration. This CO2 is subsequently removed from the body by dissolution (dissolving) after combining with another aerobic respiratory by product, water (H2O). Forming Carbonic acid (H_2CO_3) (CO2+H2O).

In solution the CO2 is able to make its way into the blood stream where it binds with haemoglobin (Haldane effect) to be transported to the lungs via diffusion for exhaling out of the body via the airways.

In a nutshell aerobic respiration is the body's ability to transport O2 from the lungs into the mitochondria of the cell and produce a very important energy source called ATP (adenosine triphosphate). ATP is then used by the body as an energy source to drive a variety of processes including muscular contractions. The body can operate without O2 (anaerobic respiration) but only for very short periods of time.

Anaerobic respiration is a form of energy production occurring in the absence of O2. However although humans have this capability it inefficient and very short in duration. Human bodies are not built to maintain perpetual and ongoing anaerobic respiration as it is super taxing and cannot be sustained for any significant period of time.

1.2 Our Breathing impacts everything about us

Breathing is the ventilation of air in and out of the body. Breathing has other functions apart from solely supporting aerobic respiration.

Ventilation is breathing. In fact it is a single breath cycle (one inhale and one exhale). I.E. The physical movement of air from the environment outside our body into our lungs. Air enters the body via the airways (mouth and nasal passages) before heading down the pharynx. At the vocal cords it flows into the trachea and eventually into the lungs passing through various branches of bronchioles and eventually arriving in the alveoli. This is inhalation. Air moving in the reverse direction is exhalation. Inhalation followed by exhalation equals one ventilation (or one breath cycle).

The manner in which we breathe impacts every function in our body. EG.

- Gas levels eg O2 and CO2 levels in the body.
- Nitric Oxide (NO) production in nasal cavity. NO has many important biological functions including relaxing walls of blood vessels, vasodilation (widening of the vessels). This increases blood flow to the heart and other organs. It acts as a signalling molecule between nerve cells and plays an important role in our immune system and fighting infections.

- Motor control and postural stability and plays several roles in physiological and psychological regulation (mind body connection).
- Maintaining homeostasis in systems such as:
    1. Emotions
    2. Heart Rate
    3. Heart Rate Variability (HRV)
    4. Vagal toning (vagus nerve function)
    5. Autonomic nervous system (Parasympathetic and Sympathetic regulation)
    6. Circulatory system
    7. Digestive system / Enteric nervous system
    8. Chemical regulation
    9. Metabolism (energy production).

In a nutshell the way we breathe affects the function of all other systems in our body. Including how well we prepare for and recover from a breath hold. If your breathing is crappy your performance is going to be the same. Crappy!

1.3 Recurring Feedback Loop

(The mind / body / breath connection)

The *recurring feedback loop (RFL)* is a circular repeating cycle of communication between the Mind, Body and Breath. Each has the ability to affect the other and each can be manipulated involuntarily or voluntarily. Being aware of the involuntary reactions of the RFL can enable us to regain control through voluntary manipulation of any of the three components. IE if you notice your breathing has changed (E.G. short fast chest breathing) you can adjust your movement by slowing it or thinking using self talk for example to bring it back under control.

The RFL is part of our in-built survival system that works by allowing any one or combination of the components (mind / body / breath) to send information in any direction which is then used to influence our behaviour and responses to whatever events we are exposed to.

For example. Lets use the scenario of being out in waves large enough that you don’t really want to be caught in the impact zone with waves breaking on your head. IE Surf conditions challenging enough that you experience heart flutters and hesitation when negotiating the break. For whatever reason you find yourself bobbing around in the impact zone and when you look out to the horizon you notice some huge lines feathering and stampeding their way to toward you. You know from your past experience in these situations that these walls of water are going to break before they pass you and very likely right on top of you.

One of the first things that will happen is that your breathing will change. Shallower, faster and higher into the chest as your body attempts to increase your heart rate and ramp up your energy to prepare you to "fight" or "flee" the perceived threat.

Note: regardless of any the threat in front of you. Whether it's a large wave, whirl pool, mad person with a gun, speeding car or what ever you body will naturally respond in the same way regardless of the threat. Caveat – Unless you have deliberately trained in behavioural responses to specific scenarios.

Lesson Two - Psychophysiology

This is the first drill we do on the course to demonstrate how powerful breathing is and how easy it is to impact our psychophysiology simply by changing the way we breathe.

The drill consists of 1 minute voluntary hyperventilation (superventilation) followed immediately by 1 minute nasal only breathing and is performed as follows.

2.1 The psychophysiology drill.

1. Lay flat on your back on the floor or sit relaxed and comfortable.
2. Breathe only through the nose using your natural breath cadence to relax.
3. Continue for 2 minutes
4. After 2 minutes.
5. Purse you lips and inhale with as much force and as hard as you can. Followed by an exhale in the same manner. Breath rate should be as fast a possible around 1 breath cycle (inhale + exhale) per second.
6. Continue for 1 minute focussing on what sensations you are feeling and what emotions you are experiencing.
7. After 1 minutes. Return to a naturally paced nasal only breathing. Breath in and out softley and quietly and in a calm, controlled manner through the nose only. Close you eyes if you feel like closing them. Pay attention to what sensations you are feeling and what emotions you are experiencing and how this differed from the previous superventilation.
8. Continue for 1 minute.
9. After 1 minute take a couple of natural breaths have a stretch and get up and move around.

WARNING: If you feel any dizziness, pain or severe tingling or disorientation during any of the exercises or drills in this course. Cease immediately. Sit or lay on your side in a comfortable position and allowing yourself return to your natural relaxed breathing rate and pace.

Now lets have a look at what was going on during this drill.

2.2 What happens during superventilation.

Superventilation is controlled hyperventilation refers to breathing (ventilation) which exceeds our metabolic demand. The superventilation you will perform may have result in you experiencing any or a combination of the following classic symptoms associated with hyperventilation:

- Dizziness
- Light headedness
- Physical weakness
- Shortness of breath
- Unsteadiness / loss of balance
- Muscle spasms / cramps (extremities)
- Tingling sensations (mouth and fingertips)
- Increased heart rate
- Feeling confused
- Feeling anxious
- Feeling stressed
- Feelings of depersonalisation (non-reality / dream-like)
- Loss of focus and concentration
- Impaired memory
- Hallucinations
- Blurred vision
- Tunnel vision
- Flashing lights
- Seeing multiple
- Saw ribs and breathing anatomy
- Changes in blood pressure
- Wheezing (Bronchi constrict to restrict loss of CO_2 – sports asthma)

Hyperventilation creates a rapid lowering of CO_2 levels in our blood which causes a narrowing of the blood vessels (vasoconstriction) that supply blood to the brain and tightens the bond between haemoglobin and O_2. Reducing its availability at a cellular level.

This reduction in blood supply to the brain and Oxygen to the cells leads to many of the symptoms listed above. Continued hyperventilation can lead to loss of consciousness.

Note: Contrary to popular belief Hyperventilation does not over oxygenate the body or increase O_2 concentration. Rather it causes a dumping of CO_2 and reduced O_2 supply to the brain and cells. Hyperventilation can make us feel very uncomfortable, uneasy and stressed and may create feelings of losing control.

Hyperventilation increases sympathetic toning (Fight or Flight response)

2.3 What happens during nasal breathing.

When nasal breathing we may have experienced any or all of the following:

- Effortless breathing
- Reduced breathing cadence (your breathing slowed down)
- Longer inhale
- Longer exhale
- Feeling of calm
- Feeling of relaxation
- Closing of your eyes
- Light abdominal centric breathing
- Increased self - awareness
- Increased self-control
- Improved mental clarity
- Improved vision
- Improved hearing
- Improved focus
- Slowed heart rate

Slow controlled nasal breathing sends a signal to our body's systems that we are in control and that everything is OK. This messaging activates greater parasympathetic (rest and recovery) toning and down regulates the sympathetic nervous (fight or flight) system rebalancing autonomic homeostasis. Increased parasympathetic dominance improves relaxation, reduces stress, improves circulation, restores our ability to rest and sleep, reduces allergies, decrease sinus congestion, improves cognitive ability, enhances physical performance and down regulates stress.

Practising slow nasal breathing regularly produces significant improvements in our physical, cognitive, mental health and overall well-being.

Benefits of Nasal Breathing:

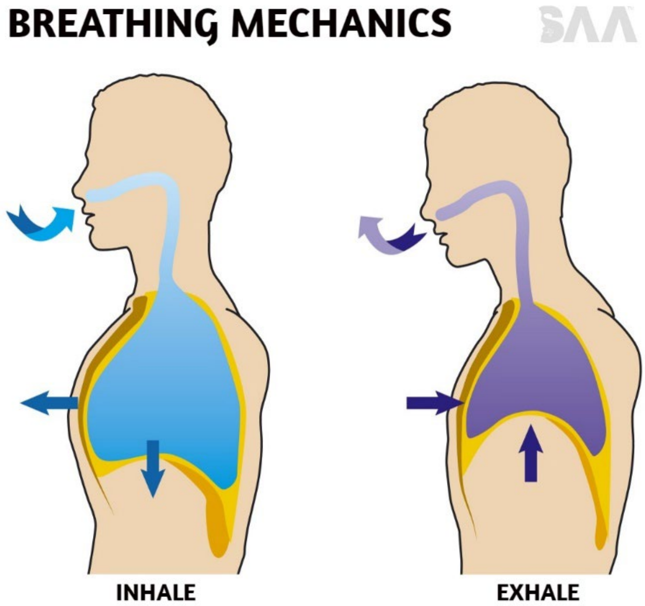
- Humidifies, Filters + warms/cools air
- Increases air flow to arteries, veins, and nerves
- Increase O2 uptake and circulation
- Slows down breathing
- Improves lung capacity and vitality
- Strengthens the diaphragm
- Reduces the risk of allergies
- Reduces your risk of asthma
- Aids your immune system
- Reduces snoring and sleep apnea
- Improves oral health

- Reduce tension and stress (Parasympathetic activator)
- Vagal nerve activation
- Enhances facial / dental development (straight teeth / square jaw)
- Prevents overexertion
- Improves recovery from illness and exercise (stress)
- Improved defence against viruses and bacteria as initiation of this process takes place in the nasal cavity (common cold)
- Microscopic fluid sacs produced during nasal breathing kill bacteria and reduce virus invasion.
- Produce Nitric Oxide – Carried to body via nasal breath
- NO - conditions vessels, tissues, combats bacteria / virus, regulates blood pressure, assists in O_2 delivery & boosts immune system.
- Increased tolerance to CO_2 / Increased O_2 increases vitality.
- Altitude training
- Athletic performance
- Humidifying
- Improves deep and REM sleep
- Improves daytime energy levels
- Improves Nitric Oxide levels and circulation in the body

NOTE: In aquatic environments and when recovering from and preparing for long or intense breath holds it is more appropriate to used controlled mouth breathing (as per the Full Lung breathing exercise we will perform in later lessons).

Lesson three – Breathing physiology.

3.1 Breathing Mechanics.



The diaphragm is a thin muscle that sits at the base of the chest and separates it from the abdomen. When you inhale your diaphragm contracts and pulls downward increasing the space (volume) in and around your lungs allowing them to expand. The muscles between your ribs (intercostals) also play a significant role to enlarge the chest cavity. They work to pull your rib cage upward and outward when you inhale again increasing the space in which the lungs can expand. As the diaphragm contracts and the thoracic cavity space increases the pressure inside the lungs is reduced to the point where it is less than atmospheric pressure outside of your body. This creates vacuum effect which draws air into the lungs(area of lower pressure) via the airways from outside the body (area of higher pressure).

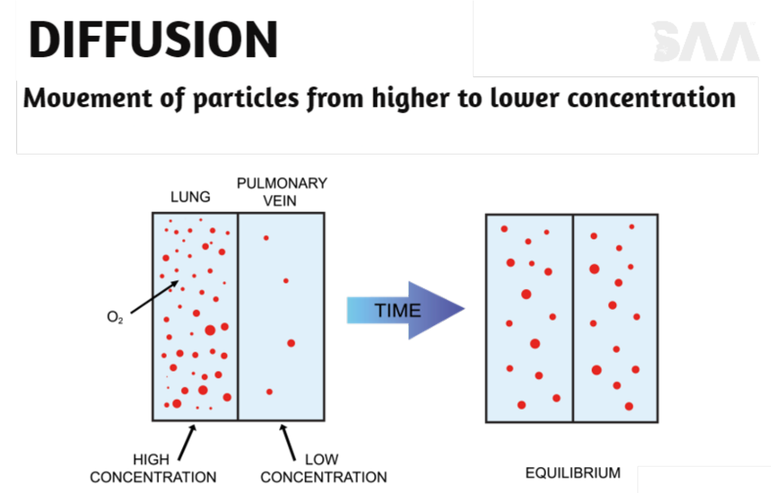
When you exhale your diaphragm relaxes upward reducing the space in and around the lungs decreasing the lung volume. The intercostals also assist by contracting the rib cage. This process increases the internal pressure of the lungs to a point where it is greater than the air pressure outside the body and causes air to move out of the lungs via the mouth or nose to the surrounding atmosphere of less pressure.

Inhalation and exhalation create a gas turnover in the lungs. CO_2 that has accumulated in the body as a result of metabolism is carried from tissues in the blood back to the lung where diffusion moves it from the blood to the air spaces in the lungs after which it is expelled via exhalation via our airways. The Haldane Effect explains the process that enables CO_2 to be eliminated. Vice versa O_2 rich air enters the body via the airways into the lungs and diffusion transfers it into the body's tissues. The Bohr effect explains the process of O_2 disassociating from haemoglobin.

An understanding of both the Haldane and Bohr effect is useful as these processes are impacted by the manner in which we breathe. The efficiency of both these processes impacts our ability prepare and recover for and from breath holds. Understanding this emphasises the importance if optimising breathing techniques to optimise breath holds.

3.2 Gas exchange in the human body.

3.2.1 Diffusion

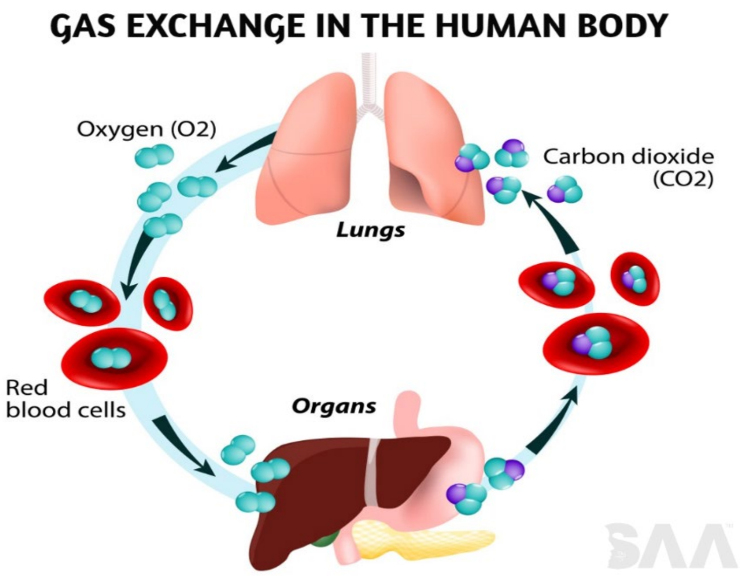


Occurs as a result of the body attempting to maintain a pressure equilibrium throughout a closed environment (Grahams Law)

Diffusion is the process by which gases are transferred from the air we inhale via the lungs into the circulatory system for transportation to tissues and organs. Diffusion occurs as a result of a gas attempting to maintain a pressure equilibrium throughout a closed environment (Grahams Law).

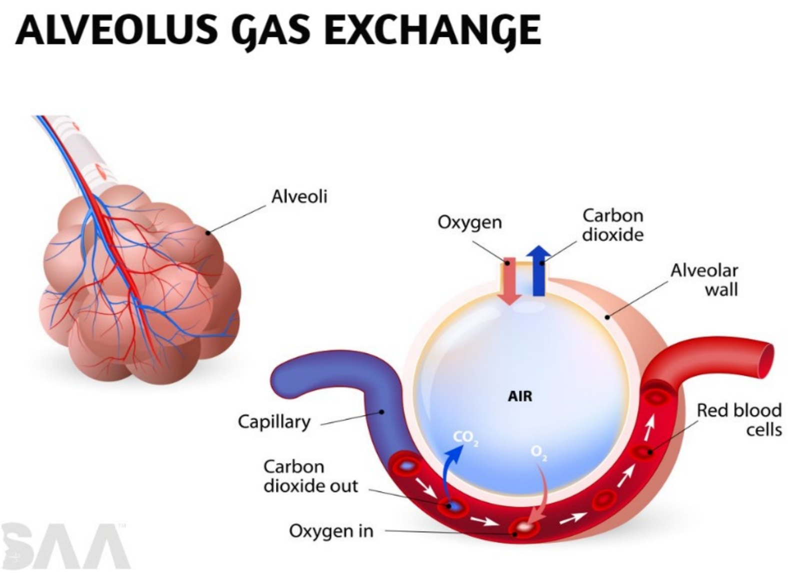
The higher the pressure exerted upon a gas the greater ability of that gas to diffuse. In a closed system pressure and temperature are directly related in that the higher the temperature of the closed space the greater the pressure and the more easily a gas will diffuse and vice versa. This is caused by the gas contained in that space "wanting" to maintain an equal pressure across all permeable portions of the system in which it exists.

If there is a position of higher pressure then a gas will diffuse to an area of lower pressure to maintain a pressure equilibrium across both regions. Pressure increases the number of particle collisions thus increases the rate and speed of diffusion. It is this process that allows gases like O2 and CO2 to move in and out of the body.



In the context of breathing and breath holding gas exchange refers to the movement of O2 into the blood and CO2 out of the blood. O2 and CO2 move across the respiratory membrane. O2 moves out of the alveolus into the capillaries while CO2 moves in the opposite direction from the capillaries into the alveolus.

Gases are exchanged between the alveolar air and the blood using the process of diffusion. IE a result of the movement of molecules from an area of higher concentration (greater pressure) to an area of lower concentration (lower pressure). The rate of diffusion can be influenced by a variety of variables. Such as. Atmospheric pressure and the magnitude of the concentration gradient of the diffusing substance.



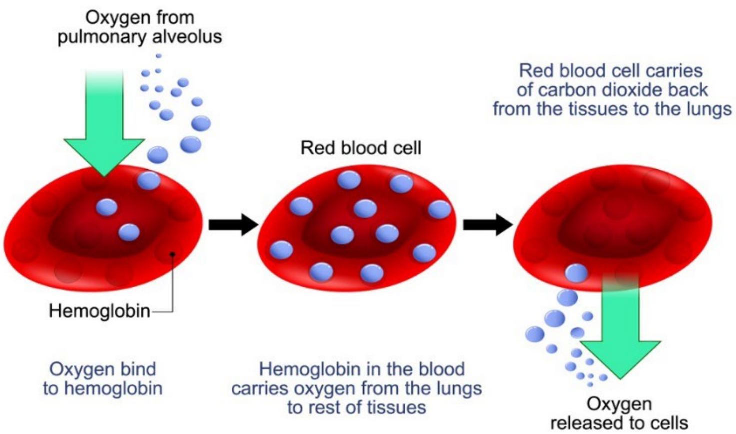
Points to remember:

- Diffusion results from a body or substance attempting to maintain a pressure equilibrium throughout a closed environment.
- The efficiency of diffusion in your body impacts the availability of O2 for use at a cellular and cerebral.
- Diffusion will cease once a pressure equilibrium is reached.

1. Increased pressure = enhanced diffusion

3.2.2 Bohr effect

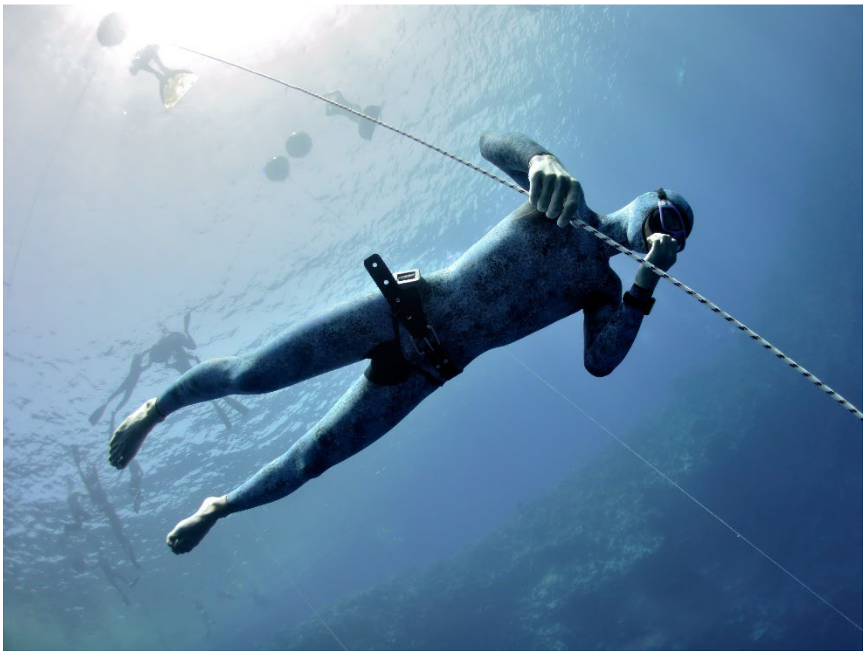
The *Bohr effect* explains the physiological phenomenon first described in 1904 by the Danish physiologist Christian Bohr and refers to the observation that increases in the CO2 partial pressure of blood (decreases in blood pH /higher acidity) result in a lower affinity of haemoglobin for O2. This is due to the difference in pH between the cells of the body and haemoglobin. Hence the presence of CO_2 is required to maintain the movement of O_2 from haemoglobin in the blood to the cells and tissue.



Lesson four - Focusing for a hold down

“Is preparing for a freedive the same as preparing for a surfing hold down?”

4.1 Freediving



Freediving although a quite different experience to the surfing hold down can offer many transferrable insights to the surfing hold down.

Freedivers are specialists at holding their breath for long periods of time. To do this they focus a great deal on the ability to relax both their mind and body in order to conserve O2 and energy and to minimise the accumulation of CO2 which drives our breathing reflex (urge to breathe).

Freediving is undertaken in a relatively controlled environment with optimal conditions and an emphasis on safety and supervision. Although it appears to the onlooker as being dangerous freediving is one of the safest extreme Sports on the planet. With only a single death being recorded in competition.

When Freediving the breath holder makes the decision of when they will begin the breath hold and what limits they will place upon themselves. EG The length, depth and duration of the dive. Freedivers undertake regular training during which they not only develop a greater capacity for breath holding but also learn to understand their limits and thresholds. They repeat the same diver over and over multiple times.

Note: Most breath holding deaths occur as a result of untrained people pushing limits beyond what can safely be performed given that person's condition and capability.

Characteristics of a freediving breath hold

- Performed when the diver chooses
- Performed when the diver is fully recovered
- Time available for optimal preparation
- All breath holds and or training is planned
- Supported and supervised by buddies and or safety teams
- Performed in a controlled or suitable environment with optimal diving conditions
- Breath holder is calm and relaxed
- Repetitive. Breath holds are repeated many times so divers become very familiar with the experience
- Parasympathetically dominant. Due to the relaxed and controlled conditions most freediving occurs and the super relaxed state they are able to maintain control of their nervous system and prevent it from entering a fight or flight response
- Intensity is controlled by the diver who may choose when to dive or return to the surface
- Usually occur following low levels of physical activity and mental stimulation.

Freedivers are**:**

- Specialists at conserving O2 / energy.
- Possess excellent body and mind awareness and control.
- Perform a great deal of progressive and repetitive practise (They do the same dives over and over).

4.2 Surfing Hold Down

Surfers are specialist at naturally developing their abilities through years of progressive exposure and play. They naturally observe and react to what is going in around them and have a good sense of their personal limitations

The surfing hold down occurs in an uncontrolled environment, it is involuntary, sudden, intense, aggressive and violent when compared to a freedive. Surfing hold downs vary in their magnitude based on many ever-changing variables, like weather conditions, water clarity, wave size, wave intensity, water depth etc. There is also a general absence of safety teams and training buddies who can come to immediate assistance.

During a surfing hold down the surfer is at the whim of the environment and mercy of the ocean. When the ocean decides to release them from being under water they can swim to the surface and take a breath. Wave frequency determines how much recovery a surfer will have. Recovery opportunities can be as little as the time to take single breath before the surfer is subjected to their next breath hold and beathing.

This may occur multiple times before the surfer is afforded time to fully recover. The choices associated with freediving are not available to the surfer.   EG The length, depth and duration of the breath hold is determined by the wave and ocean conditions.

Surfing hold downs by nature are:

- Sudden
- Unexpected
- Violent
- Anticipation (stress)
- Fear / Anxiety / Panic
- Hyper Alert
- Elevated heart / breath rate
- Physical

- Sympathetic response
- Vary in intensity at the whim of the elements
- Usually occur after high levels of physical activity.

Points to remember:

- Preparation is different for a freedive and surfing hold down
- The way we recover and prepare for each is also different
- Despite the differences there are also common factors inherent to both.

4.3 The Challenge

When Freediving we generally have total control over this but with surfing the ability to surface and breathe can often be dictated by the ocean environment. Regardless of the difference between these two modalities. When under water on a single breath we face the same challenge. That is. At some stage we must return to the surface in order to our next breathe.

To optimise our survivability during a hold down we can focus on the few things we do have control over in what may appear to be a relatively out of control situation.

1. When under water on a single breath we have limited stored energy and O2 and we need to be mindful of conserving both.

2. The way our body and mind reacts to a situation can affect our energy and O2 consumption rate. If we can remain calm and relaxed both in body and mind we use much less O2 and energy than when we are stressed and physically active.

3. The brain uses around 25-30% of the body's total energy and O2 consumption. Keeping a calm and relaxed mind can significantly reduce of use of O2 and energy and therefore extend our survivability time under water.

4. Regardless of the situation we have a choice of how we will behave. Our behaviours and responses can be engrained by developing physical and mental adaptions through progressive training and exposure. Even when it may feel like you have absolutely no control over a situation you always have a choice about how you will respond.

Lesson Five – The urge to breathe

5.1 What drives the urge to breathe?

Being aware of and recognising the physiological and psychological changes that occur within us as we navigate a breath hold help us to understand what the urge to breathe (feeling that you need to take a breath) is and what the driving force is behind it. From a young age most people associate the feeling of having to take a breath (the urge to breathe) with low O2 levels. Because of this thinking when we initially experience the urge to breathe we associated it with suffocation and the perception that we must take a breath or we will die.

However. The urge to breathe is not primarily driven by low O2 levels and therefore any urgency associated with it is purely a perception that we have unwittingly trained in over the course of our lives and experiences based on our misgiven association it with and low O2 (suffocation)suffocation. Once we understand that the urge to breathe is not an indicator of low O2 or that we are about to suffocate we can begin to relax and challenge the duration of our breath holds.

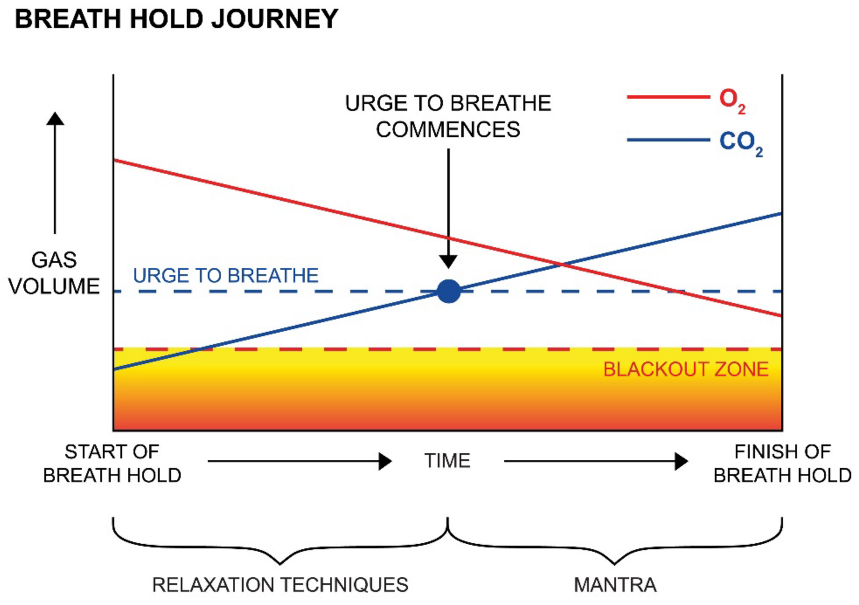
Remember from section 1.1 CO2 is a product of aerobic respiration and is transported from the cells and tissues to the lungs for exhaling during normal breathing. When we hold our breath we prevent the exhalation of CO2 from our body. Once the levels of CO2 in our body reach the point where we would normally take a breath our brain and body goes into action sending reminders throughout our various systems to encourage us to breathe. These reminders arrive in the form of swallowing impulses, diaphragmatic contractions, other muscle contractions eg chest and throat and can get gradually more aggressive and violent.

This process relies on our body's sensitivity to the rising levels of CO2. CO2 is carefully monitored by the body via its chemoreceptors as its presence impacts the function of all our systems. Such as blood pH, the acid / alkaline balances and organ function. Every individual has a unique sensitivity to CO2 based on the way they breath (chemosensitivity). Our sensitivity to CO2 is calibrated by a central governing set point in the brain and in the course of normal breathing that sensitivity triggers our breathing response (when our body decides to inhale and exhale).

Note : The body will react to critically low levels of O2 but not until it is critically low (20-30%) in which case it will generally immobilise you (black out). A major take away from this course is that participants understand what is driving the urge to breathe. As knowing it is not driven by low O2 enables you to push through the initial discomfort of the urge to breathe and significantly lengthen your breath hold. In reality breath holding is all about manage the stress created by CO2 and the urge to breathe.

A simple drill to demonstrate this is to use an oxypulsemeter during your breath holds and observing your O2 levels whilst experiencing strong urges to breathe. Most people are extremely surprised to see that after a couple of minutes of holding their breath their O2 saturation levels are remain close to normal in the mid to low 90%. Add to this the knowledge that the average person can safely push your O2 saturation to below 70% (depending on your training and personal nuances). Relaxing during breath holds should become a lot easier.

As depicted in the Breath Hold Journey diagram below when a breath hold is performed following normal Breathing. The urge to breathe kicks in on the average person around 50% of the way through their total capacity (general only) and is well clear of any cerebral black out risk (black out resulting from the brain being deprived of O2).



5.2 Practical - "Breath Hold Journey" drill.

Equipment required for this drill:

1 x Oxypulsemeter

1 x nose clip (optional)

The drill consists of two breath holds. Dont worry about how to breathe up and prepare for or recover from breath holds just yet. It does not matter how long your breath hold goes for with this drill. What you need to focus on are the sensations you experience during the breath hold and what the thing was that prompted you to breath. IE how you felt physically and mentally and what was it that made you take a breath.

The average person at sea level when Breathing normally will have an O2 saturation of around 97-99% as measured by the Oxypulsemeter. Check this before you start this drill. If your resting O2 saturation is 95% or below and remains there. You should consult a medical professional.

- Be mindful when using an oxypulsemeter that there may be a delay in the reading of up to 20 seconds with most oxypulsemeters. So you may find once you start breathing after the breath holds the oxypulsemeter will indicate your O2 saturation is still dropping. Disregard this as within 30-45seconds your with normal Breathing your O2 saturation will return to its full or near full capacity.

Breath hold 1.

1. Relax and when you are ready take a last breath in and hold it for as long as you can.
2. During the breath hold be sure to block your nose by pinching it with your fingers or wearing

a nose clip. Do this by pinching your nostrils closed with your thumb and forefinger. This ensures there is no sneaky breathing (unintentional breathing that can occur via your nose as pressure builds up in your airways). This helps to intensify

3. Continue the breath hold until you need to breathe.
4. Rest with natural nasal breathing two minutes
5. Think about what triggered your ceasing of the breath hold and taking of a breath.

Breath hold 2.

Following your 2 minutes rest from breath hold one attach the oxypulsemeter to your finger and activate its functions so you are able to observe your O2 saturation.

Repeat as per breath hold one but this time use the oxypulsemeter to keep track of your O2 saturation. When you feel like you need to breathe observe where your O2 saturation is at. Remember it does not get critical until you are at 20-30% and it is perfectly safe for most healthy people to drop it into the 70 or 60%s. Now push yourself a little further beyond what you felt in the first breath hold.

1. Relax and when you are ready take a last breath in and hold it for as long as you can.
2. During the breath hold be sure to block your nose by pinching it with your fingers or wearing a nose clip. Do this by pinching your nostrils closed with your thumb and forefinger. This ensures there is no sneaky breathing (unintentional breathing that can occur via your nose as pressure builds up in your airways). This helps to intensify the experience and also enables you to push a bit harder.
3. When you feel the urges to breathe come on push a bit harder and beyond the point at which you chose to breathe in breath hold one.
4. Continue the breath hold until you need to breathe whilst observing your O2 levels.

What was your O2 saturation when you needed to breathe?

Unless you are a trained freediver or breath holder it is unlikely your O2 saturation dropped below 90%. Some people on their first few breaths hold have very little to no change in O2 saturation at all due to them givingin to the urge to breathe. A well trained breath holder with a five minute static breath hold may be around 85% sPO2 saturation at the 4 minute mark. So this gives you a reasonable idea of 1. How long a breath hold you may have and 2. How the urge to breathe is not driven by low levels of O2. But rather high levels of CO2.

After you commence breathing following the breath holds have a couple of minutes to rest and relax. During this time think about what drove your decision to resume breathing and what sensations and changes in your mind and body you experienced as the breath hold progressed?

This is a powerful exercise and most first time breath holders are surprised by how little O2 they actually use when holding their breath. Reality is. During normal breathing in a relaxed state the body uses only around 4% of inhaled O2 the rest is expelled during exhalation.

5.3 Your response to elevated CO_2

CO_2 is an irritant gas accumulating as a by-product of metabolism (aerobic respiration) but also a regulator of many important bodily functions including your breathing dynamics. For this reason the brain keeps a close eye on CO_2 levels in the body.
Some of things CO_2 does include:

- Stimulate Breathing
- Adjust blood chemistry (lowers pH and increases acidity)
- Dilates capillaries
- Drives the Bohr Effect

High levels of CO_2 (above the central governing set point relative to an individuals "normal" breathing will trigger a much harder more forceful breathing pattern as the body attempts to recalibrate gas levels by dumping out what it perceives as excess CO_2.

Remember. The brain also measures O_2 levels in your body but does not take action unless it is critically low (20-30% saturation).

5.4 Suffocation Alarm Response

The suffocation alarm response is possibly a response that promotes a feeling and thinking you experience when holding your breath (or when you are out of breath) that you will suffocate if you do not take a breath. The purpose of the alarm is to stimulate you to breathe.

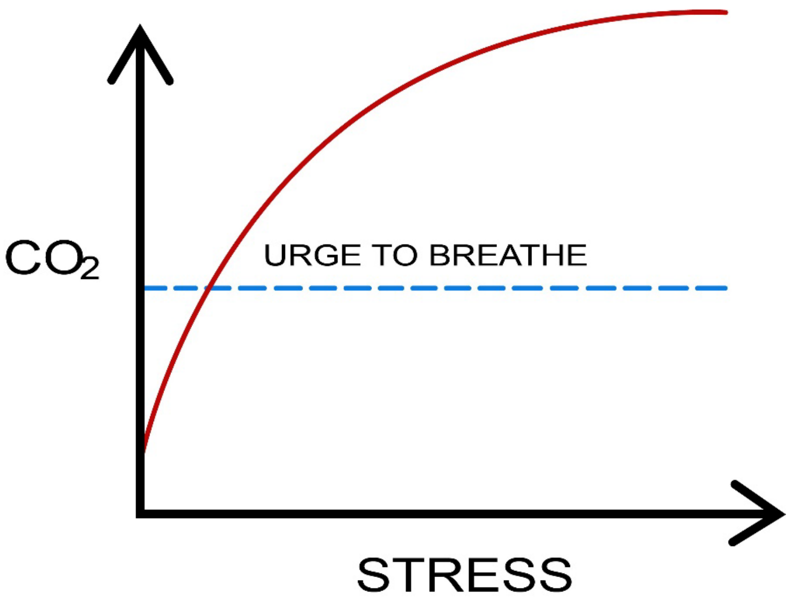
The "suffocation alarm response" is associated with the urge to breathe and is driven by high levels of CO_2 not low O_2.

- You have a CO_2 tolerance set point based for your everyday breathing patterns
- The way you breathe impacts your bodys tolerance to CO_2
- Increased CO_2 triggers innate sympathetic (fight or flight) response and stimulates the fear of suffocation.
- Increased CO_2 triggers an anxiety / panic response via
  the amygdala. The amygdala in the limbic system and plays a key role in how we assess and respond to environmental threats and challenges by evaluating emotional importance of sensory information. Its main job is to regulate emotions such as fear and aggression. The amygdala is also involved with linking emotions to our memories, reward processing, and decision-making.
- suffocation alarm response is supported by learned behaviours associated with your relationship with CO_2 and your perception of what the urge to breathe indicates EG "*AAAAAAGHHHHHHHHH I'm running out of air and will die if I dont take a breath soon!!!!!!*"

5.5 CO2 and stress

CO2 is often referred to as the stress molecule as it is frequently associated with our ability to manage stress. This is due to CO2 being an irritant gas that stimulates our urge to breathe by creating a psychophysiological stressors.

As CO2 increases your stress increases and vice versa. This can be depicted in the diagram below. The greater tolerance to CO2 we have the greater our tolerance to stress. Our tolerance to both CO2 and stress can be improved with progressive exposure (familiarity created by training and practise).



Lesson six – Breath Hold Journeys

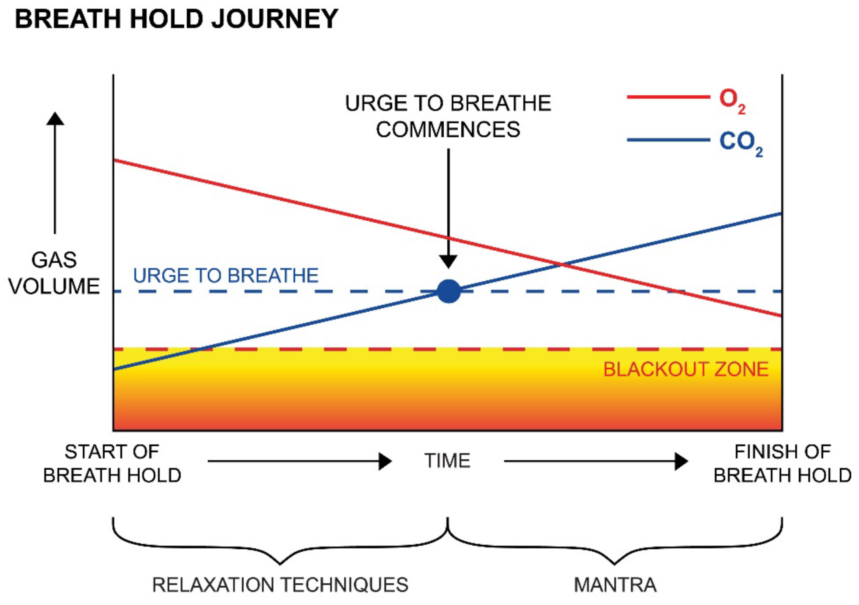
6.1 The Breath Hold Journey

The Breath Hold Journey is the combination of psychological and physiological sensations we experience whilst navigating our way through a breath hold. Breath holding is as much a mental exercise as it is physical so it helps to understand the processes going on in our body and mind so we can use that knowledge to find our way through the challenge.

There is a saying amongst freedivers that goes like, "The breath hold does not begin until the urge to breath kicks in". Meaning that the real challenge of holding your breath does not really begin until all those little breathing reminders and stress kick in. The better you can tolerate higher levels of CO_2 and manage the stress of all those little reminders trying to get you to breathe, the further youll be able to push through the back end of the breath hold and the longer your breath hold duration will be.

An important component of the *Breath hold Journey* is to understand, be aware of and be in control of our bodily sensations. Plus learning how to occupy our mind to distract ourselves away from the concept of time and those sensations including those sent to prompt us to breathe. The *Breath Hold Journey* diagram below shows how O_2 and CO_2 volume change

during a breath hold commenced post normal relaxed breathing and how the urge to breathe can provide a safety mechanism by prompting us to take a breath well before we near any risk of unconsciousness.



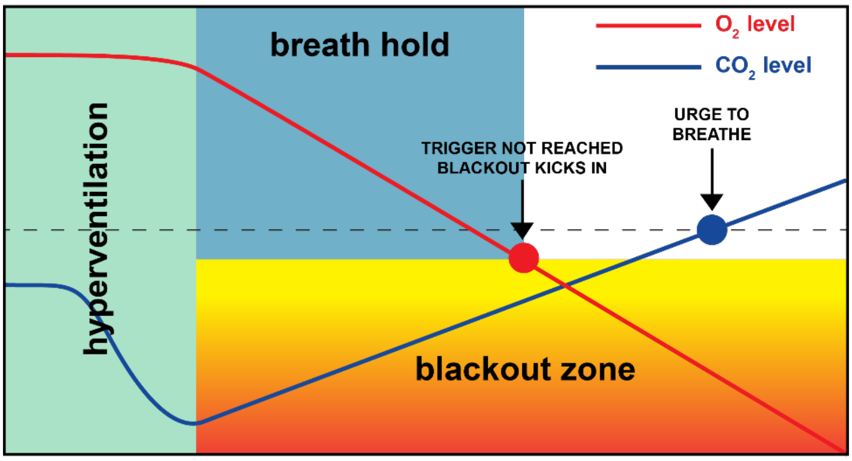
Remember:

- High CO2 drives our urge to breathe and is the driving force behand the stress we experience during challenging breath holds.
- During a breath hold that follows normal breathing the urge to breathe kicks in way before any risk of blacking out (at around 50% of the average healthy persons total breath hold duration).
- The urge to breath can be our best friend as it provides an indicator of our breath holding limits
- The urge to breathe helps prevent black outs.

6.2 Hyperventilation

Hyperventilation is "Breathing in excess of our metabolic demands" That is. An excessive rate and depth of breathing that results in an abnormal loss of CO2 from the blood. The below diagram shows the O2 and CO2 gas relationship during a breath hold following hyperventilation. This practise can result in a dumping of CO2 reducing levels of the gas to a point where it would significantly delay the urge to breathe.

HYPERVENTILATION



Delaying the urge to breathe during longer breath holds can result in an unintended black out. This due to O2 levels reaching critical limits before CO2 levels rise enough to trigger the urge to breathe and stimulate the breath holder to take a breath.

Rapidly lowering CO2 levels in the body delays our need to breathe. Creating a scenario where O2 levels can drop to below critical levels prior to the breath holder feeling any urge to breathe. This significantly increases the risk of black out and death. Particularly when we are underwater.

Remember:

- Hyperventilation flushes CO2 out of the body and excessive hyperventilation disturbs the delicate gas balance within the body by lowering normal CO2 levels and delaying air hunger (urge to breathe).
- When the urge to breathe is delayed we are at greater risk of black out!
- Black out can result from O2 levels reaching critical limits before CO2 levels rise enough to trigger an urge to breathe that is strong enough to stimulate the recommencement of breathing.

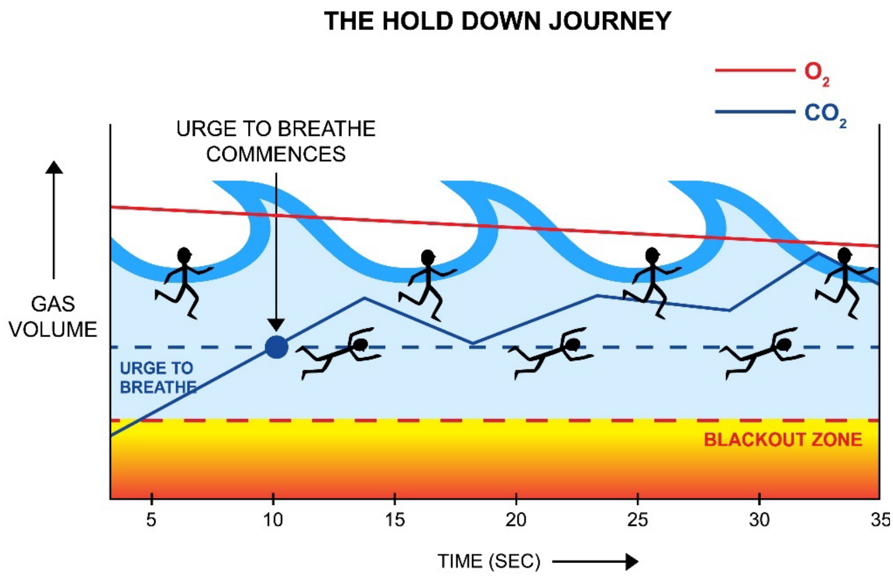
6.3 The Surfers Hold Down Journey

The *surfers hold down journey* is unique in the fact that breath holds are not generally long enough to deplete O2 reserves. According to some big wave surfers a rule of thumb for hold downs is one seconds per foot of wave height. EG A ten-foot wave would on average produce a ten second hold down (depending individual wave nuances and variables). However. Because of the high physical activity associated with surfing (paddling, etc) surfer's bodies are loaded with much higher-than-normal levels of CO2.

This results in the urge to breath commencing very early on in the breath hold. Meaning surfing hold downs can feel pretty ugly quite early on (within a few seconds of being submerged). This is compounded by the repetition of the hold downs (like a paddle out scenario).

When paddling out through a surf break or when “caught inside” the surfer is working hard physically and generating excessive amounts of CO2 whilst having to perform repeated short duration breath holds with limited to no recovery opportunity. And. Although they are short in duration the repetition and lack of recovery maintains high levels of CO2 in the body which generates higher levels of stress. This is why CO2 is often referred to as “The stress molecule” or “stress hormone”.

An example of a surf breath hold journey is depicted in the diagram below. The CO2 and O2 gas levels through out the experience and also where they are in relation to the black out zone. Caveat. As multiple hold downs become longer O2 depletion will accelerate and the risk of blackout will increase.



6.4 Superventilation

For scenarios where we generate excessive CO2 it is possible to use a form of controlled hyperventilation to quickly recalibrate the CO2 in our system returning it closer to normal and more manageable levels. This reduces CO2 induced stress, enables us to take a better last breath and relax more for the next hold down.

Controlled hyperventilation is referred to as superventilation. Taking 3 -5 superventilation breaths following and prior to a short intense breath hold can safely bring ‘excess’ CO2 levels back to ‘normal’ resting levels without inducing any risk of black out. This enables the surfer to maintain a more relaxed and less stressed state. Subsequently improving the taking of their next last breath and mental state when under water which reduces O2 and energy consumption. This in turn allows the surfer to optimise recovery between subsequent breath holds and make much better and more rational decisions.

Lesson 7 – Focussing during breath holds.

7.1 Relaxation techniques

The relaxation phase of the breath hold precedes any strong urge to breathe and is ideally maintained for as long as possible.

Relaxation techniques include:

- Closing the eyes (reduces sensory input and promotes relaxation)
- Body scanning (isolating, visualising and relaxing each body part).
- Visualisation (creating a picture or movie in your mind using your imagination. EG. A work project, physical activity, or passion)
- Remote viewing (projecting your mind to receive information from elsewhere without having to leave your body).
- Out of body experience (perceiving the world from a location outside of our physical body).
- Audio imagination EG Playing verses, poetry, singing or playing music in your head
- "Being the water" (imagine yourself melting into the water and becoming at one with it or becoming the water itself)
- Listen to the sounds around you and visualise what is making the noise you are hearing
- Listen to or feel your heart / pulse beating.
- Deconcentration of attention. Opposite to concentration. The dismantling of stimulus in the field of perception EG not focusing on any particular point in a field of vision or sound. Allow all stimulus to flood your sensors.
- Take off your watch! (avoid any reference to time this can spark a reaction that may result in you wanting to breathe)

- Flow. With whatever is going on in and around you. Go with the swallows and contractions as they come. As CO_2 starts to build in your system it will generate muscular contractions in an attempt to make you breathe. Try not to fight these. Rather focus on their rhythm and flow with it.

Try out a few different methods of relaxation to find the one that best works for you then stick with that one.

7.2 Mantras

Once the carbon dioxide begins to accumulate in your system to higher than normal levels it will begin irritating you in attempt to force breathing. Things will start to get quite uncomfortable.

Once this begins try to relax into it as much as possible and not fight it. The key is to remain as relaxed and least stressed as possible. However. Eventually the pressure and contractions will become increasingly severe and it will be virtually impossible to remain relaxed as your body spasms and convulses in an attempt to induce breathing.

This is when we need to switch from relaxation techniques to something more powerful like a *mantra*. Traditionally a *mantra* is a sacred word, sound or phrase repeatedly recited in an attempt to harness and focus the power of the mind. The word itself is derived from two Sanskrit roots; 'manas' meaning 'mind' and 'tra' meaning 'tool'. Mantras are "tools of thought," used as a means to direct the focusing of the mind and change our perceptions of existing realities influencing our behaviour and active outcomes.

During the challenging end of a breath hold switch from your chosen relaxation technique to a short sharp phrase and repeat that phrase over and over to negotiate the ensuing discomfort. Remember to keep your phrases short (only a few simple words) and in the third person ("You" statements) so that it gives the perception of a coach or trainer speaking to you. This is much more powerful than trying to convince yourself using "I" statements.

Examples of breath hold mantras:

- Simple but firm counting "1234,1234,123…"
- Short third person phrases EG "You're the boss, you're the boss, you're the boss…".
- "You didn't come this far to only come this far". Although a little wordy Is a well-known and very powerful phrase.
- "You've got this" and "Hang in there" or "Stay with it, its only CO_2" are others.

Try out a few different mantras to find the one that best works for you then stick with that one.

7.3 Conserving O_2 and Energy

O2 consumption = increased CO2 production = increase in stress.

The brain is only 2% of the body's mass but it is responsible for up to 30% of all O2 / glucose consumption in our body. Per gram of body mass, the brain uses energy ten times faster than any other tissue or organ in the body. Oral conversation increases brain activity by 30%. This is because oral conversation is a very complex process and requires a high rate of brain activity.

Our brain is responsible for around 25 - 30% of the body's total energy and O2 consumption so minimising brain activity during breath holds reduces CO2 production and O2 consumption. Keeping brain activity to a minimum also helps calm our state of mind and slow our thinking, reducing stress and subsequently O2 and energy consumption. During a breath hold closing the eyes is a one way to reduce sensory input which reduces brain activity enabling us to maintain deeper states of relaxation.

Minimising movement and physical activity also reduces CO2 production and O2 consumption. Remembering the principal roll of aerobic respiration is to produce fuel for muscular contractions. By reducing our muscular contractions (movement and physical activity) we are reducing the requirement for energy which in turn reduces the need for O2 and CO2 production.

Less stress = less CO2 production and less O2 consumption. And. Less CO2 production = less stress and less O2 consumption. Remember the Recurring Feedback Loop? The same system applies here.

Lesson 8. Setting up the breath hold.

8.1 Taking a last breath

To enable the taking of the best last breath possible we need to practise using the full extent of our lungs and breathing musculature. To do this we use a full lung breathing exercise during which we break down the inhale into three phases and cueing points. The three cueing points we will be using for taking a full lung of air are Stomach, Ribs and Chest.

Regardless of any situation during which we may need to hold our breath, we always and whenever possible need to optimise our last inhale. The *Full Lung Breathing* drill is a fundamental drill that develops efficient and effective breathing habits by creating greater awareness and control of your breathing. Used with nasal breathing this drill can also provide a very simple and effective relaxation tool. The same drill can be adapted for use in taking a quick but solid last breath prior to a sudden breath hold.

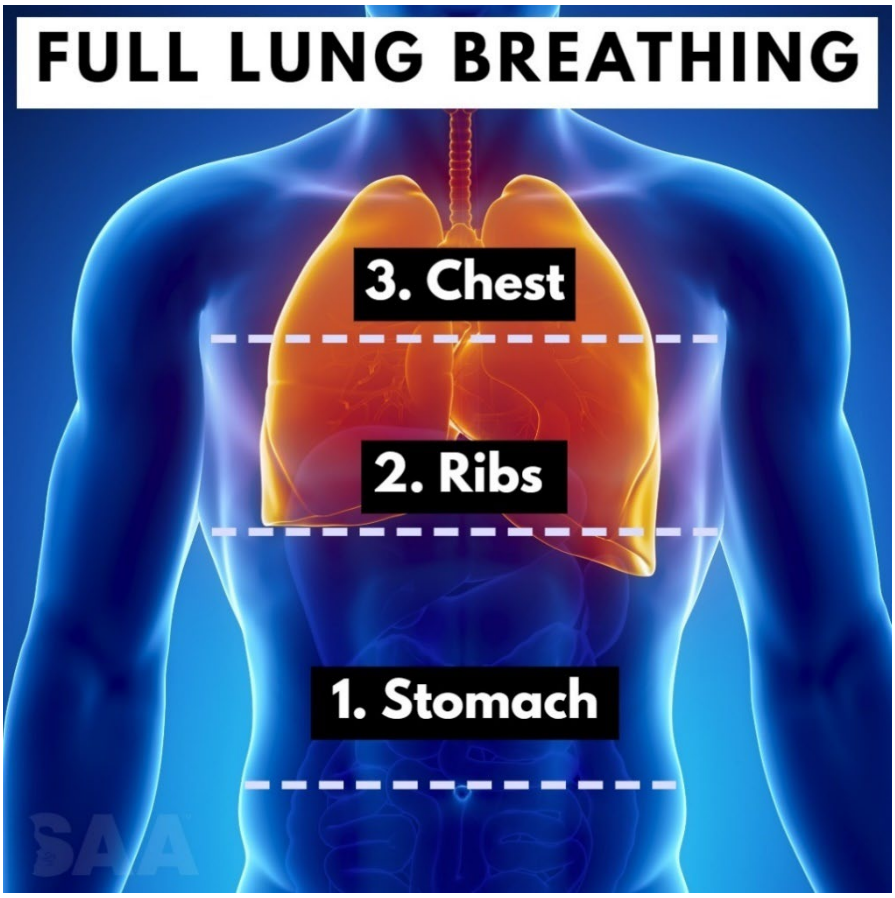
When drawing in a full lung of air we ideally start low (around the stomach region) pulling air in from the lower lobes of the lungs and filling upward toward the chest area (upper lobes). The lower lobes have more parasympathetic nerve receptors than the upper lobes. These are stimulated when we breathe low triggering a stress reduction / calming effect.

There are many benefits of initiating an inhale by breathing low including those on the list below.

- Activates parasympathetic toning
- Reduces effects of the stress hormone cortisol.
- Lowers heart rate.
- Can lower blood pressure.
- Improves core muscle stability
- Slows breathing rate which expends less energy.
- Reduces over all stress.

8.2 The last breath drill

When used for relaxation the aim of *full lung breathing* is to soften and quieten the breath to a point where air flow and body movement is undetectable. If practising the relaxation version of this drill it is possible you may become so relaxed you will fall asleep on the floor! The secret for relaxation is to reduce your breath cycles (inhale + exhale) to 3-5 cycles per minute. This creates a resonance effect that resets the frequency of all systems in the body.



8.2.1 Version 1 - Relaxation

1. Lay flat on your back on the floor and get comfortable (place a pillow or cushion under your back if required to relax your back).
2. Breathe only through the nose using your natural breath cadence.
3. Place your hands lightly on your stomach and breath only into your stomach (lower lung lobes). As you inhale feel your stomach and circumference of your lower torso expand. Think of your torso as a 360° cylinder. All sides need to expand when you inhale and contract during the exhale.
4. Inhale for a count of 4-5 and exhale for a count of 10-15 (Note: when exhaling you are releasing the same amount of air as you inhaled but slower and with more control. If you're not able to perform 5/15 try 2/6 or 3/9. Wherever you fall maintain the ratio of 1:3 for Inhale : Exhale.
5. Continue for 2 minutes.
6. After 2 minutes slide your hands up either side of your body to your lower ribs and breath only into your rib region. As you inhale allow your ribs to open and expand and again ensure the 360° circumference of your torso EG the middle back is also expanding. Your middle back should press gently into the floor as you inhale and fill with air.

7. Exhale. Let everything relax and your ribs collapse. If you're having trouble moving your ribs use your hands to lightly press them in when you exhale and release the pressure allowing them to expand when you inhale. This will provide sensory feedback that will help getting any sticky ribs moving again.
10. After 2 minutes slide your hands up to your chest and breath only into your chest. As you inhale allow your chest to expand and ensure the circumference of your torso EG upper back and lats are also expanding. Your upper back should press gently into the floor and your upper ribs should fan out as you inhale.
11. Still breathing through the nose only. Combine all 3 stomach, ribs and chest into one single movement while inhaling and exhaling. Once you've got the hang of this focus on the timing of your breath. Inhaling for 4-5 counts, slight pause then exhaling gently and controlled for 10-15 counts followed by another pause at the bottom of the exhale then inhale again. Continue for 4 minutes.

Total time 10 minutes.

8.2.2 Version 2 – Last breath in

1. Lay flat on your back on the floor and get comfortable. (LEVEL ONE)
   - Sit in a chair (LEVEL TWO)
   - Lay face down on the floor (LEVEL THREE)
2. Breathe through your mouth using pursed lips (like you are sucking air in through a straw). During the exhales use your tongue to create resistance (making an SSSSSSSSS sound) and controlling the exhale.
3. Place your hands on your stomach and breath only into your stomach. As you inhale draw as much air in as quickly as you can and feel your stomach and circumference of your lower torso expand. Think of your torso as a 360° cylinder. All sides need to expand when you inhale and contract during the exhale.
4. Inhale firmly for a count of 4-5 and exhale for a count of 10-15 releasing the same amount of air as you inhaled slowly and with control. If you're not able to perform 5/15 try 2/6 or 3/9. Wherever you fall maintain the ratio of 1:3 for Inhale : Exhale.
5. Continue for 2 minutes.
6. After 2 minutes slide your hands up either side of your body to your lower ribs and breathe only into your ribs. As you inhale allow your ribs to open and expand and again ensure the 360° circumference of your torso eg middle back is also expanding. Your middle back should press gently into the floor as you inhale and fill with air.
7. Exhale slowly and with control. Let everything relax and your ribs collapse. If you're having trouble moving your ribs use your hands to lightly press them in when you exhale and release the pressure allowing them to expand when you inhale. This will provide sensory feedback that will help getting any sticky ribs moving again.
8. Continue for 2 minutes.

9. After 2 minutes slide your hands up to your chest and breath only into your chest. As you inhale allow your chest to expand and ensure the circumference of your torso EG upper back and lats, etc are also expanding. Your upper back should press gently into the floor as your upper ribs fan out as you inhale.
10. Continue for 2 minutes.
11. After 2 minutes. Combine all 3 stomach, ribs and chest into one single movement while inhaling and exhaling. Once you've got the hang of this focus on the timing of your breath. Inhaling filling up as fast as possible.
12. Hold your breath for ten to fifteen seconds then exhale slowly and with control for 10-15 counts followed by another short breath hold at the bottom then inhale again. Continue for 4 minutes.

8.2.3 Version 3 – Add in the breath hold

1. Lay flat on your back on the floor and get comfortable. (LEVEL ONE)
    - Sit in a chair (LEVEL TWO)
    - Lay face down on the floor (LEVEL THREE)

2. Initial relaxation. Breathing through the nose only. Combine all 3 stomach, ribs and chest into one single movement while inhaling and exhaling. Once you've got the hang of this focus on the timing of your breath. Inhaling for 4-5 counts, slight pause then exhaling gently and controlled for 10-15 counts followed by another pause at the bottom then inhale again.
3. Continue for 2 minutes.
4. After 2 minutes. Commence with breathing as per the combined stomach, ribs and chest (Version 2 - Last breath -section 11/12).
5. Continue for 2 minutes.
6. After 2 minutes switch to breathing through your mouth using pursed lips (like you are sucking air in through a straw). During the exhales use your tongue to create resistance (making an SSSSSSSSS sound) and controlling the exhale (as per Version two). Continue the full lung (Stomach, Ribs and Chest) sequence for 2 minutes.
7. After 2 minutes. Take an inhale as fast as possible and hold your breath for 60 seconds.
8. After 60 seconds resume breathing with whatever comes naturally an inhale or exhale and continue to breath during the recover as per 2. Initial relaxation phase.
9. Continue relaxation breathing for 45 seconds.
10. After 45 seconds switch back to pursed lip mouth breathing and within 15 seconds take another strong fast inhale and hold your breath for 60 secs.
11. Repeat this cycle 5 – 10 times always maintaining control of your breathing as per the relaxation phase during the recovery period.
12. Finish with 2 minutes super relaxed nasal only breathing using your natural breath cadence.

8.3 Throat Locks

Freedivers use a variety of tongue locks to assist with equalisation at depth or when going deep. Tongue locks also provide a nice way of sealing off our airways (throat) during more intense phases of a breath hold.

During the relaxation phase of a breath hold, gentle / relaxed pressure is all that is required to create a seal. However. As the breath hold intensifies gradually increase the pressure applied via the tongue to the hard palate (hard bone on the roof of mouth) to match the increase in intensity from the breath hold.

Two preferred tongue locks used by Apnea Survival are the "T "and "K" lock.

8.3.1 The T lock

The T-lock is when the front of your tongue makes contact with the front of the roof of the mouth on the hard palate and is in the same position as when you make the "T" sound. Mouth remains closed.

8.3.2 The K lock

The K-lock is when the middle of your tongue makes contact with the centre of the roof of your mouth on the hard palate. Like you're going to make a "K" sound. Mouth remains closed.

Both the T and K lock are performed with the tongue making contact with the hard palate.

8.4 The Human Diving Response

The *Human Diving Response* (AKA dive reflex or mammalian dive reflex) is a set of physiological reflexes to breath holding and immersion water. The response overrides basic homeostatic reflexes and is found in various air-breathing vertebrates other than humans.

The response optimises respiration by preferentially diverting O2 stores to the heart and brain which minimises O2 consumption and enables immersion in water for extended periods of time. The response presents strongly in aquatic mammals like seals, dolphins, and whales and exists as a lesser response in other animals, including humans and diving birds such as ducks and penguins.

The diving response is triggered specifically by the need to conserve O2 during breath holds is enhanced by a cool wetting of the skin (sensors) around the nostrils, mouth and nasal cavity while breath-holding. The response is sustained by neural processes originating in carotid chemoreceptors and stimulated by lowering blood O2 levels, rising CO2 and blood acidity.

The most noticeable effects of the response on the cardiovascular system are:

- Bradycardia (Slowing of the heart rate) – triggered by immersion in cool water and rising CO2.
- Peripheral vasoconstriction (redirection of blood from extremities to the vital organs) – triggered by rising CO2

- Spleen contraction (release of red blood cells stored in the spleen) and in humans changes in HRV. Triggered by individual sensitivity to hypoxia) and can also be stimulated independent of the diving response.
- Blood shift (Occurs as a result of pressure exerted on the body beyond 40 -50 Meters of depth when blood is shunted to organs in the chest cavity to occupy the spaces created when air in the lungs compresses. The alveoli are engulfed in blood plasma from the surrounding tissues. As blood is (for our intents and purposes) an incompressible fluid when it replaces the empty space when lungs compresses).

Physiological responses

When the face is submerged and water fills the nostrils, sensory receptors sensitive to wetness within the nasal cavity and other areas of the face supply parts of the autonomic nervous system and vagus nerve with information that produces bradycardia,elicit peripheral vasoconstriction, restrict blood flow to limbs and other organs to preserve blood and oxygen for the heart, brain and lungs, concentrating flow to the heart–brain circuit. This allows us to conserve O_2.

Mild bradycardia is caused by holding the breath without submerging the face in water. When breathing with the face submerged the diving response increases proportionally to decreasing water temperature. However. The greatest bradycardia effect is induced when the subject is holding their breath with their face cool and wet.

Children tend to survive longer than adults when deprived of O_2 underwater and it is thought, for this reason, the dive reflex is strongest in humans at birth and diminishes the more time we spend bipedal (walking and out of the water).

You can do the following simple experiment with an Oxypulsemeter and supervised by a buddy at home.

8.4.1 Human Dive Response demo

Fill a bucket or bowl (big enough to immerse your mouth and nose in) with cool water 5-10 °C (seems to be most effective in subjects we have used for the demo on our face to face course). If the water is too cold, it will provoke a Cold Shock response and create higher stress levels that will override the dive reflex and provide a completely different response).

1. Place the bucket of water on the floor or a table where you can comfortably immerse your face (mouth and nose) in it. Note: You do not need to submerge your entire head.
2. Use an Oxypulsemeter to monitor your heart rate.
3. Relax and prepare for a breath hold.
4. Hold your breath and immerse your face in the cool water.
5. Have your buddy film the oxypulsemeter.
6. Remain in the face down breath hold position for 45 -60 seconds.

You should see a distinct drop in your heart rate through the duration of the breath hold. The drop may be as prevalent as 105bpm to high 20s in as little as 30 seconds depending upon individual nuances.

Warning: Only perform this drill in the presence of a competent buddy and cease this drill once heart rates drop into the low 30s.

Lesson 9. Recovery breathing

Hypercapnia Vs Hypoxia

Definition Hypercapnia

- Hyper – Higher than normal levels
- Capnia - CO_2 in blood
- Hypercapnia – Higher than normal levels of CO_2 in the blood.

Definition Hypoxia

- Hypo – lower than normal levels
- Oxia – Oxygen
- Hypoxia – Lower than normal levels of oxygen

9.1 Hypercapnia training (CO_2 Tolerance)

Hypercapnia or CO_2 retention training consists of drills performed with a higher-than-normal carbon dioxide (CO_2) levels in the blood. CO_2 is elevated during exercise and normally expelled through the lungs by increased breathing. When we hold our breath CO_2 is not expelled and accumulates in our blood and lungs and drives a much stronger urge to breathe. This can result in a very intense exercise experience.

Hypercapnia training results in the body becoming more tolerant of high levels of CO_2 and to stress generally. Hypercapnia training is characterised by maintaining high levels of O_2 saturation coupled with short duration intervals consisting of moderate to high activity, limited rest periods and short breath holds (high intensity interval training). This training significantly elevates the body's CO_2 levels increasing the intensity of the breath hold and reducing our ability to completely off load accumulating CO_2. It can become very intense and uncomfortable very quickly but at the same time it is a very safe training method. Due to a strong urge to breath becoming intolerable long before O_2 is depleted. Meaning the breath holder will be forced to breathe long before there is any significant risk of O_2 deprivation, loss of motor control (LMC / Samba) or black out.

Hypercapnia training tables are commonly used by professional freedivers (around 70% of their training) and are the most appropriate form of training for surfers. There are many flow-on adaptions from hypercapnia training for all athletes and anyone who is wishing to develop any form of stress management.

Hypercapnia training can be performed on land or in the water. Hypercapnia training is high in intensity but low in risk. Hypercapnia training is the principle breath hold technique taught by Apnea Survival due to its specific applicability to unexpected and intense aquatic immersion scenarios and its low risk profile.

Hypercapnia training benefits include:

- Increased tolerance to high levels of CO_2
- Increased tolerance to stress
- Increased performance during high stress situations

- Enhanced exercise and breath hold recovery times
- Enhanced dive response activation
- Makes breath holds more comfortable
- Lengthens breath holds

9.1.1 Example of a hypercapnia training table

The CO_2 static table is designed to adapt the body to higher levels of CO_2 by reducing the rest duration between fixed breath holds. The duration of the timed breath hold should not exceed 50% of your personal best (PB) and the table should consist of no more than 8 cycles. The following 8 cycles are based on a personal best static breath hold of 3 minutes. Total duration 25:15 min.

Rest	**Hold**
1.00	1.30
1.00	1.30
1.00	1.30
1.00	1.30
1.00	1.30
0.45	1.30
0.30	1.30
0.15	1.30

As you progress adjust the table to suit new PBs by changing the breath hold duration to 50% of your improved breath hold time.

9 .2 Hypoxia training (O2 deprivation)

Hypoxia is a condition in which the body or a region of the body is deprived of adequate oxygen supply at a tissue level. Hypoxia may be classified as either generalised - affecting the whole body or localised - affecting a region of the body. Eg brain – cerebral hypoxia. Hypoxia training is characterised by a deficiency in the amount of O2 reaching the body's tissues.

Due to its nature of depleting the body's O2 reserves which significantly elevates the risk of cerebral hypoxia (black out) Hypoxia training should only be used by experienced breath holders and when under supervision of a competent training buddy.

Although there can be many benefits to Hypoxia training, these techniques are not used on the Apnea Survival Surf Apnea course and are not a necessary part of training breath holds for surfing and other short duration, unexpected and intense aquatic immersion scenarios. It is more applicable to freediving than surfing.

Hypoxia training builds tolerance to low O2 environments by creating an environment low in O2 using progressively increased breath hold durations.

9.2.1 Example of a Low O2 Tolerance Static Table

The below static table adapts the body to lower levels of oxygen by increasing breath hold length and maintaining set resting periods. The length of the last breath hold in the table should not exceed 80% of your current max breath hold with no more than eight cycles. The following table is based on a max breath hold of 3 minutes. Total duration 30:45 min.

Hold	**Rest**
1.00	2.00
1.15	2.00
1.30	2.00
1.45	2.00
2.00	2.00
2.15	2.00
2.30	2.00
2.30	2.00

As the breath holder progresses adjust the table to suit new PBs by changing the breath hold duration to 80% of your improved breath hold time.

Note: Always be cautious when performing Hypoxia breath holds, know your limits and always restrict your exertion to 7/10. This ensures there is limited to no risk of blacking out!

9.3 Recovery breathing techniques

9.3.1 Surfing hold downs and hypercapnia training

During Hypercapnia training levels of CO2 in the body can increase in pressure to an intolerable point forcing us to breathe. Blood pressure also increases and it is not uncommon for the breath holder to experiences sensations of wanting to urinate. This is the body's way of dumping fluid as it attempts to relieve itself from the increased blood pressure.

Due to the typical high intensity and short recovery opportunity provided by surfing hold downs and hypercapnia training it can be difficult to use preferred freediving breath hold (O2 Deprivation) recovery techniques such as hook breathing and forced inhales immediately upon surfacing. Nor are these techniques necessary or appropriate for O2 rich, short duration breath holds with limited recovery opportunities. The priority here is to quickly unload excess CO2 and set up the best possible last breath prior to the next hold down or breath hold.

For the surfing hold down scenario (as per 6.3 Surfers Hold Down Journey) That is. Multiple short duration high intensity breath holds with a normal to high O2 saturation, it is preferred to use superventilation (controlled hyperventilation for 3-5 breaths as per 2.2 What happens during superventilation) starting with an exhale immediately upon surfacing for 3 – 5 breaths (if possible) before returning to natural relaxed breathing if there is an opportunity to do so or taking the next last breath if required for a subsequent hold down.

Each scenario will dictate how many breaths you get to take. Sometimes it may be only one solid exhale followed by the last inhale. The superventilation helps quickly eliminate excess CO2 built up following the previous breath hold and brings CO2 levels back closer to normal levels. Due to the relatively short duration of surfing hold downs we should never be depleted of O2 if we get a good last breath in and hold on to all our air so this technique is perfectly safe when used in the appropriate setting.

9.3.1 Longer breath holds and hypoxia training

During Hypoxia training O2 saturation can be depleted to near critical levels. For this reason we use freediving (O2 Deprivation) recovery technique of inhaling first immediately upon surfacing followed by a short pause then a passive exhale for 3 - 5 breaths before trying to lower CO2 levels. This technique helps to keep the pressure of O2 in the lungs high enough to maintain diffusion.

As we are often depleted of O2 when training hypoxia any forced exhalation may result in loss of internal O2 pressure which negatively impacts the process of diffusion reducing the ability of O2 to move from the lungs to blood vessels and tissues. A consequence of this can reduced O2 delivery to the brain and extremities resulting in loss of motor control (samba) or black out.

9.3.2 Hook breathing.

The inhale first or hook breathing technique maintains pressure in the lungs and increases diffusion of O2 rich throughout the body.

How to do hook breathing for freediving

1. As soon as you resurface inhale.
2. Hold your breath for 1 – 2 seconds while following step 4 below.
3. Create pressure around your lungs. While holding your breath exert slight force onto your lungs by flexing your abs, ribs diaphragm and chest
4. Passive Exhale. After 1 – 2 seconds passively exhale the air out your lungs (don't force it).
5. Repat 3 breath cycles (steps 2 – 5).
6. Commence normal natural breathing. Do not hyperventilate just breathe at a normal, natural pace.
7. Rest.

- The noise made during the inhale ideally sounds like "HOO" (as in 'whoo')
- The noise made when exerting pressure through the lung space ideally sounds like the start of a word beginning with K IE a short 'Ka' sound.
- Together both the 'HOO' and the 'K' "HOOK". Hence the name 'HOOK' breathing.

Lesson 10. Our stress response

10.1 Stress

Stress is either a physiological or psychological response to a stressor. A stressor is a stress causing stimulus. IE is a chemical or biological agent, environmental condition or an event that challenges or threatens an individual's safety or survival. Stress is how our bodies react to that challenge or threat.

Physiological stressors are those that you notice in your body first and include a range of physiological responses from muscle tightness (tension) to injury and illness. For example. Over worked muscles can become tight and sore and that ache or muscular pain can make us irritable. When this occurs, the pain is causing a stress response. Physiological stressors can also be subtle. For example. If our body is fighting off an infection, we can be impacted both physically (aching muscles, muscular fatigue and lethargy (due to glucose and O2 (energy)- being diverted to the immune system) and mentally (brain fog and inability to focus).

Psychological stressors are those that come from your mind. For example. When sensory cues remind us of a past traumatic events (near drownings) and cause us to ''emotionally'' relive the experience which then triggers physiological changes in the body. The physical threat may not be real but our memory relives the story of the past traumatic event causing us to have an emotional experience as though the threat was real.

Psychological stressors include high pressure situations (expectations to perform) such as job interviews, work deadlines or formal assessments. There is no actual physical threat but our comes stress because of the meaning we attach to the situation. For example. Failing an exam or trying to deliver a presentation to meet the expectations of other people. We create psychological pressure within ourselves.

Stress can be defined by three key descriptors.

1. Physiological or psychological tension
2. Internal or external forces
3. Exceeding a person's resources for their ability to cope

Stress enables us to cope effectively with a threat and plays a critical role in our survival. However. Although the stress response happens automatically it is not always accurate. Sometimes we respond even when there is no real threat.

10.2 Our Stress response

The stress we experience can be both psychological or physiological and is triggered by the release of *stress* hormones such as adrenaline and cortisol via processes initiated by the hypothalamic–pituitary–adrenal (HPA) axis. During periods of stress the production of these specific hormones triggers physical changes in the body.

These changes result in the production of additional energy and an up regulation of capabilities required to increase our performance when responding to threats (specific stressors). This chain of reactions triggers an increase in heart rate, blood pressure, and breathing rate. Priming the body for action and preparing it to perform under pressure.

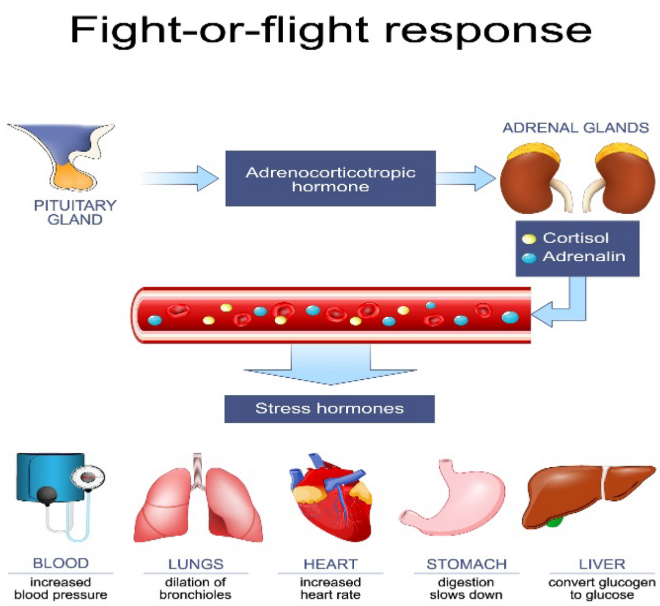
10.2.1 Changes that occur in response to stress

Psychological:

- Increased focus and attention
- Increased alertness
- Difficulty concentrating on anything away from threat
- Reprioritising of activity / function
- Reduced cognition (prefrontal cortex shuts down as midbrain takes over for more rapid decision making)

Physiological:

- Dilated pupils – Increase visual awareness of surroundings. Pupil dilation allows extra light into the eyes improving vision
- Pale or flushed skin- Blood flow to the surface areas of the body is reduced while flow to the muscles, brain, legs, and arms is increased. Paleness or alternating between a pale and flushed face as blood rushes to the head and brain is common.
- Blood clotting- The body's blood clotting ability increases to prevent excess blood loss in the event of injury
- Heartbeat increases - Provide the body with the energy and oxygen needed to fuel a rapid response to danger
- Respiratory rate increases – Circulates more O2 around the body and dumps CO2. Prolonged over breathing can also lead to hyperventilation and panic attacks
- Trembling- The muscles tense and become primed for action
- Blood pressure- increases
- Increased cortisol production - Results in an increased availability of glucose in order produce more energy to facilitate fighting or fleeing
- Increased adrenaline production - increasing respiration, blood flow to muscles, output of the heart, pupil dilation response and blood sugar levels
- Bowels – Relax to evacuate and save energy
- Immune system – Suppressed (not required in a fight)



10.2.2 The hypothalamic–pituitary–adrenal (HPA) axis

The body's system used to cope with stress is the hypothalamic-pituitary-adrenal axis (HPA axis) system which was first described by Physiologist Hans Selye in 1936.

The sensations of stress we experience are triggered by the release of specific hormones such as adrenaline and cortisol via processes initiated by the HPA axis. During periods of stress the production of these specific hormones triggers physical changes in the body that result in the production of additional energy and an up regulation of capabilities required to increase our performance when responding to a perceived threat (stressor).

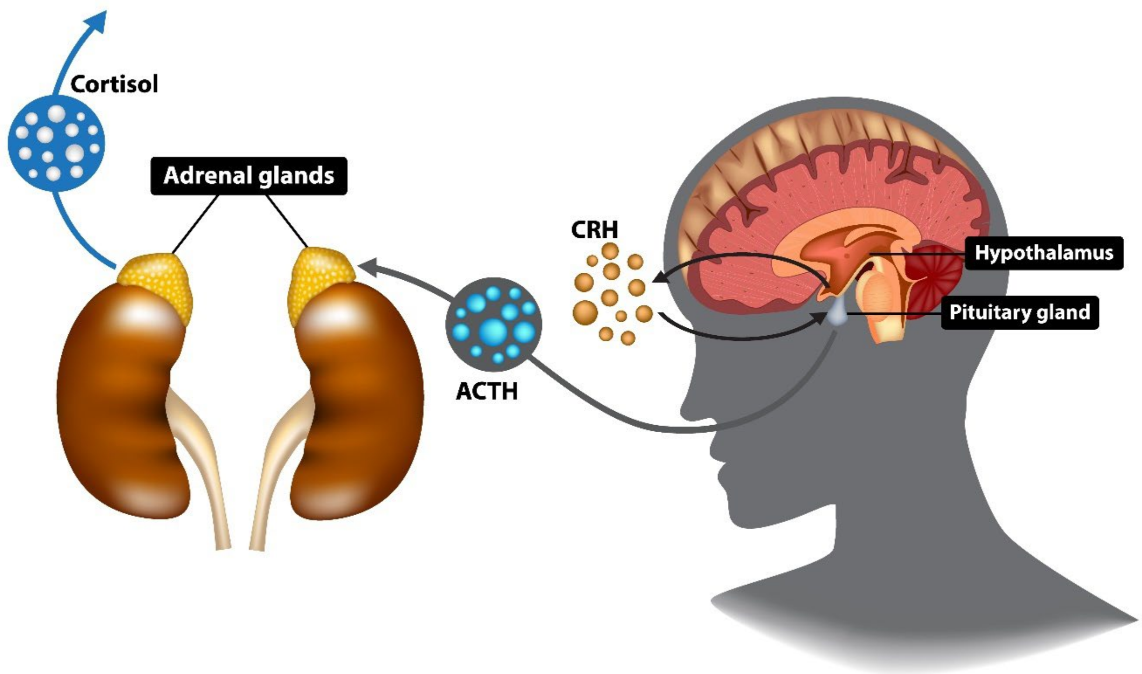
1. When you perceive a dangerous or stressful situation information is sent to an area of the brain involved in emotional processing called the amygdala. Once a threat is perceived by the amygdala it sends a signal to another area of the brain called the hypothalamus.

2. The hypothalamus being the command centre of the brain then communicates with the rest of the body through the sympathetic nervous system transmitting a signal to the adrenal glands. When the adrenal glands receive this signal, they respond by releasing adrenaline and cortisol into the bloodstream.

3. The release of adrenaline is often referred to as an "adrenaline rush". Once in the bloodstream adrenaline:
    - Binds to receptors on liver cells to break down large sugar molecules (glycogen) into more usable sugar (glucose) boosting muscle energy.

- Binds to receptors in the lungs causing us to breath faster.
- Stimulates the heart to beat faster.
- Triggers blood vessels to constrict and directs blood toward major muscle groups.
- Stimulates perspiration.
- Binds to receptors on the pancreas to inhibit the production of insulin.

Cortisol on the other hand shuts down functions in the body which are not necessary for the immediate response to the perceived threat. Including the immune, digestive and reproductive systems. This is done to prioritise the body's energy for the systems that are directly involved in dealing with the present threat. The subsequent result is an increased availability of glucose for energy to facilitate fighting or fleeing.



10.2.3 Emotional hijacking (AKA Amygdala hijacking)

Emotional hijacking is a state in which our *emotions interfere with the functioning of our brain*, resulting in reactions such as aggression or irrational fear-based behaviour.

Psychologist David Goleman introduced the concept of emotional hijacking in 1995 in his book '*Emotional Intelligence: Why It Can Matter More Than IQ'*. Referring to "amygdala hijack", Goleman wrote about how important the amygdala was because it serves as our emotional processor and how it can take over our behaviour and dominate the parts of our brain that normally aid rational thinking.

An amygdala hijack causes the prefrontal cortex to shut down making it difficult to think clearly, inhibiting our ability to make rational decisions. This action results in the triggering of the HPA Axis and our stress response system. Which as you now know gets us ramped up ready to take flight or to fight. The amygdala can serve to “hijack” our brain when we are faced with a stressful / threatening situation. As previously stated in 10.2.2 the HPA Axis, the amygdala prepares our body to react as if the situation we are anticipating presents a real danger to our ongoing survival. Although in most cases, there may be no real danger.

An emotional hijack will generally result in aggressive reactions or a panic attack. Which can pose significant consequences for both our decision-making ability and eventually our well-being. This is why, it is crucial to recognise the psychophysiological cues that precede a hijacking. Increased self-awareness = increased self-control and better decision making. Particularly during critical situations.

It is important to distinguish the difference between being ‘emotional’ and being emotionally hijacking. Feeling and recognising emotions is a perfectly normal behaviour for humans however when our emotional processor takes over, we need to regain control. Recognising what triggers an emotional hijack allows us to interject and control our response.

The level at which we can recognise and control our emotions is referred to as emotional intelligence. If we are emotionally intelligent person we have a robust connection with the emotional part of their brain, are well-tuned to our emotions and thinking. A benefit of being emotionally intelligent is the ability to de-escalate our emotional responses and prevent a hijacking.

We can train emotional intelligence through practices using exercises that increase awareness of the present moment, tune us into our surrounds and intercept any circular, negative and internal narrative.

10.2.4 The Emotional Audit

A tool that can help with the development of self-awareness and self-control

is an “Emotional Audit.” An emotional audit is a set of strategic questions that can shift our focus during emotionally charged events by activating specific areas of the brain. For example:

- *What am I thinking?* (Basal ganglia- integrates feelings, thoughts and movements).
- *What am I feeling?* (Basal ganglia- integrates feeling thoughts and movements) Temporal Lobes – emotional stability, name it to tame it – labelling affect.)
- *What do I want now?* (Cerebellum – executive functions connects to Prefrontal Cortex (PFC), cognitive integration).
- *How am I getting in my way?* Prefrontal Cortex – learning from mistakes.
- *What do I need to do differently now?* (Prefrontal Cortex –the boss supervision of life – executive functioning planning goal setting, insight) (Anterior Cingulate Gyrus brain’s gear shifter– sees options go from idea to idea).

10.3 Effect of stress

It’s not always possible to prevent stress and sometimes stress can be positive and motivating. Finding the balance between stress that is productive and stress that is detrimental is the key. Unmanaged acute stress can become chronic and may cause long-term health problems. Physical symptoms of prolonged stress may present as any of the following:

1. Breathing. Involuntary over breathing (hyperventilation) is a compensatory mechanism occurring in response to changes in the body’s chemistry resulting from higher levels of hormones like adrenaline and cortisol. This can lead into a myriad of ongoing health consequences such as high blood pressure, asthma, chronic inflammation, weight gain and heart problems.

2. Stomach (gut). When stressed we produce more glucose to provide the additional energy required to flee or fight. If this happens to frequently it can increase the risk of type 2 diabetes. Adrenaline and cortisol can also upset digestion and cause reflux.

3. Muscles. We tense in preparation for a ‘fight or flight’ response and to protect your body from a potential injury. After a stressful event our muscles should relax and blood pressure should return to normal. However. If we are continually exposed to stress muscles have less opportunity to recover / relax. This can cause physical symptoms such as ongoing muscular pain. Back, neck and shoulder pain are symptoms commonly associated with chronic stress.

4. Immunity. Our immune system is stimulated to help heal wounds or injuries. Periods of stress can interfere with the function of our immune system making us more vulnerable to infection and illness and retarding our ability to recover.

5. Skin and hair. Stress hormones increase oil production which can make skin more sensitive and oilier and over time may cause acne or hair loss.

6. Fertility and sexuality. Ongoing chronic stress leads to your mind and body being exhausted and fatigued. This impacts the reproductive system and may reduce your desire for sex or lead to fertility problems.

Things that relieve stress.

1. Relaxation. Daily rituals that release tension in your body and your mind. EG relaxed breathing exercises for ten minutes before going to bed.

2. Exercise. Known to reduce stress due to imitating the completion of the stress response cycle (physical feat - fight or flight) which activates the down regulation of the stress response. A simple thirty-minute walk or social sports game can down blow off the residual effects of stress.

3. Greater awareness. Knowing what triggers your stress allows you to better understand and control it.

4. Learning how to control the stress cycle (recurring feedback loop).

10.4 General adaptive syndrome – G.A.S.

The General adaptation syndrome or G.A.S. (AKA Stress response) is the body's reaction to stress. It was originally described by Hans Selye an Austrian-born physiologist in 1936. Although he never won it Seyle received a total of 17 Noble peace prize nominations for his work. Selye referred to the stress response as general because it had a ***General*** effect upon large portions of the entire body. ***Adaptive*** because it stimulated a defence to the stress and ***Syndrome*** because it was dependant on the manifestation of an individual's nuanced reaction to the stressor.

Seyle gave G.A.S. 3 distinct phases.

1. Alarm reaction - Immediate reaction to the stressor. EG Fight flight or freeze.

2. Resistance / adaption - During this phase the body makes changes on many levels in order to reduce the effect of the stressor ie adapts to the stress it is exposed to.

3. Exhaustion - The body's resistance to the stress may be reduced or may eventually be overwhelmed. EG a stressful job may cause long-term mental stress that results in a physiological shut down of all systems such as burn out, chronic disease or heart attack.

Selye observed people's perceptions of stress impacted the way their bodies responded to it. He believed people's perceptive responses were at times more dangerous than the actual stressors (actual thing triggering the response) themselves.

All performance-based activity / training is about stress adaption. Whether you're breathing, not breathing, moving, lifting, bending, or mobilising or whatever. The intent is to provide a repeated stress that encourages your body's systems to adjust to cope with the environmental change and maintain its homeostasis. Hence it is important for any training program to be balanced with the optimal ratio of stress and recovery and to be particularised to the requirements and ability of the individual. Not enough stress can result in poor adaption. Too much stress can result in system breakdown.

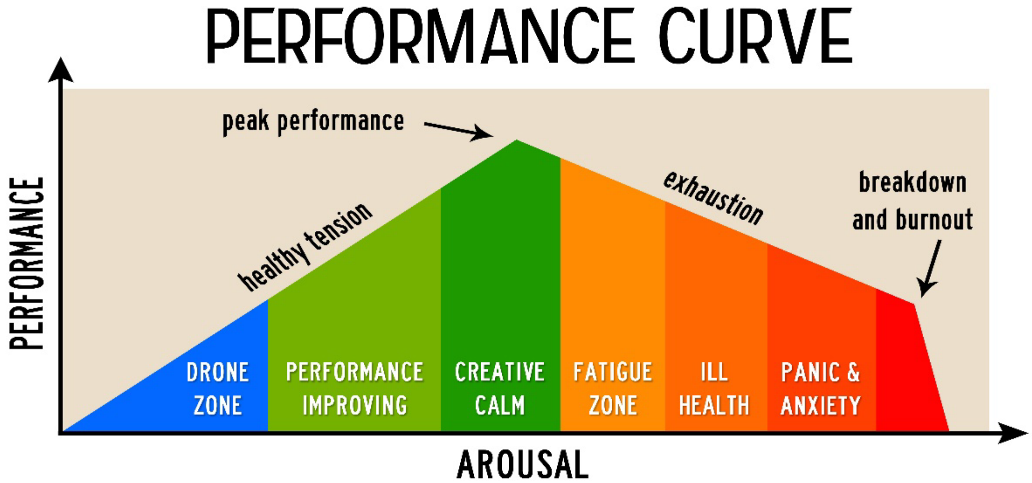
"It is not stress that kills us. It is our reaction to it" – *Hans Seyle*

Selye's interest in stress began when he had observed patients with various chronic illnesses like tuberculosis and cancer displayed common symptoms that he attributed to what we now know as stress. Selye also observed similar responses in laboratory animals. For example. Rats exposed to cold, drugs, or physical injury exhibited a common pattern of responses to these events (stressors).

Selye later changed the term G.A.S. to "stress response". Selye argued that stress differs from other physical responses in that the stress response is identical regardless of whether the provoking stressor is positive or negative. He called negative stress "distress" and positive stress "eustress".

10.4.1 Distress V Eustress

The diagram below is based on the *Yerkes Dodson Stress Performance Curve* and explains how some stress can be beneficial to our performance.



LESSON 11. Fear

11.1 Definition

Used as a noun fear is given the following meaning by the Merriam Webster dictionary.

An unpleasant often strong emotion caused by anticipation or awareness of danger and to experience anxious concern or reason for alarm (sense danger).

As a verb fear is given the following meaning by the Merriam Webster dictionary.

To be afraid or feel fear.

Stress, fear and anxiety can be quite similar. You feel fear in response to danger and experience stress. Later, you may experience anxiety when you again experience the same symptoms associated with your initial response but now it occurs in the absence of any present danger. Fear can be referred to as the anticipation of a perceived outcome. This perception being based on what our memory recollects from similar past events and experiences and what we believe may result from current circumstances based on that experience.

Fear is experienced as an unpleasant emotion which arrives in response to how we perceive a situation as being a danger or threat to our survival (although the danger may not be real). Fear provokes our stress response which subsequently triggers physiological changes that may produce behavioural reactions such as fighting or fleeing. These sensations can feed a self- perpetuating cycle of fear and stress, increasing the perception of impending doom and distorting further the genuineness of the any real threat or lack thereof.

Fear is nicely tied into our stress response and is modulated by cognition and learning. It can also be deemed as either rational (appropriate) or irrational (inappropriate). A phobia for example is an irrational fear as there is no real danger present to warrant a fight or flight reaction. We can sum fear up as a feeling of unease or apprehensiveness in response to an event we perceive as an imminent threat. This response has been preserved within us throughout evolution as a survival mechanism and can be either conditioned or unlearned.

We can condition our fear by reinforcing it through our behaviour. EG if we are afraid of suffocating whilst holding our breath our defence mechanisms are being conditioned to that perceived danger. Such behaviour further supports our belief (perception) that the danger is real.

We cannot entirely extinguish our fears but we can unlearn them. Through incremental and progressive exposure to small and tolerable doses of the relevant stressor. This is the basis for *hormesis*, a characteristic of organisms used to adapt through small doses of exposure to increasing amounts of a stressor. IE small doses of a stressor are generally favourable even though a large dose may be detrimental. So going back to our breath hold and suffocation example, by regularly experiencing slightly more challenging breath holds than we are normally comfortable with, we can learn to tolerate higher stress loads which results in us becoming more comfortable with more challenging breath holds.

The flow on effect of hormesis in relation to fear is that we come to realise the reality of the danger and can better manage ourselves when exposed to that stressor (behavioural conditioning). In other words, we adapt.

11.2 Pavlov's dogs – Behavioural conditioning

Pavlov's dog experiment provides a great analogy for the concept of how behaviour can be conditioned. Behavioural conditioning- AKA Pavlovian Conditioning / Pavlov's Dogs Experiment. Below is an extract from Spall, B. (2020, May 29). Pavlovian Conditioning: Ivan Pavlov's Dogs Experiment. https://benjaminspall.com/pavlov-dogs which describes the behavioural conditioning discovery made by Ivan Pavlov.

Pavlov (1849-1936) won the Nobel Prize in Physiology or Medicine in 1904 for his work on the physiology of digestion. Pavlov's most well-known contribution to science was through his dog experiments, which became the basis for Pavlovian conditioning (AKA classical conditioning).

Pavlov's dog experiment took place in the 1890s. Small tubes were implanted into the cheeks of dogs to measure the build-up of saliva under a variety of conditions. The experiment came about as part of an accidental discovery. Pavlov had at the time been conducting research experiments into the dogs' gastric systems. As part of this research, Pavlov and his assistants would enter the room where the dogs were housed with a variety of edible and non-edible items, with the intention of measuring the amount of saliva that each dog produced when each item was placed in front of them.

Pavlov's prediction that the dogs would salivate when presented with edible items was soon proved correct. This represents an unconditioned response, in which the sight and smell of the food causes them to salivate. While conducting his gastric experiment, Pavlov noticed something else about his dogs. He noticed the dogs would begin salivating not when food was placed in front of them, but when they heard the footsteps of the lab assistant coming down the hall to bring food to them. Pavlov soon realised he could teach his dogs to associate almost any sound, item, or event with the reward of food. The salivation was a conditioned response.

The most famous item used in Pavlov's experiment was a bell. Pavlov would ring a bell before feeding his dogs. The single act of ringing the bell was enough for the dogs to associate the ringing with the delivery of food.   In the same way that unconditioned stimulus causes an unconditioned response, Pavlov confirmed the commonly agreed-upon theory that a neutral stimulus causes no response. An example of this was the act of Pavlov ringing the bell before dogs had been conditioned to the bell ringing preceding food. If the bell was rung while it was still a neutral stimulus there was no salivation. IE no response occurred.

11.3 Managing fear

Fear can never be extinguished entirely but it can be unlearned and our responses to the stressors that trigger it can be better managed. Part of this process is recognising the stressor responsible for generating the fear we experience and developing a greater tolerance to the stressor. For example. Our initial fear of thinking we will die from hypoxia when we first experience the urge to breathe while holding our breath is an example of how fear is conditioned. Once we develop a tolerance to the provoking stressor (CO_2) through understanding our physiology (education) and incremental exposure to that stressor (training) the stressor causes much less concern and any fear of being suffocated whilst holding our breath is reduced.

Steps to controlling fear.

1. Accept fear is a necessary survival tool and is always going to be a part of life.
2. Rationalise all components of situations that provoke fear and understand the real nature of the danger (if any).
3. Mentally work through worst case scenarios and outcomes without any attached emotion. Use visualisation techniques to put yourself in these scenarios with favourable outcomes.
4. Identify the triggers (stressors) of your fear and challenge them through progressive and controlled exposure (practise and training - create adaptations).
5. Gradually progress your training from controlled environments to real life situations taking small steps that reinforce successful outcomes.

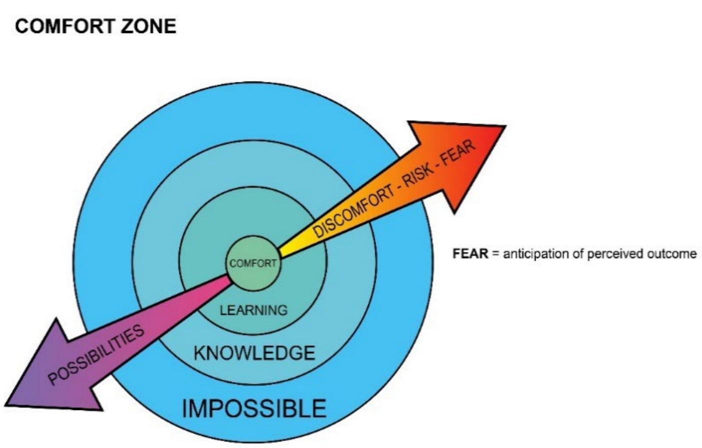
11.4 Comfort Zone

The concept the *comfort zone* became popular in the 1990s after it was coined by management thinker Judith Bardwick in her 1991 work *Danger in the Comfort Zone*. She referred to the *comfort zone as:*

" A behavioural state within which a person operates in an anxiety-neutral condition, using a limited set of behaviours to deliver a steady level of performance, usually without a sense of risk."

Within the comfort zone we experience feelings of familairity, feel at ease, in control and have low stress levels. Here we feel safe, secure and comforatble with both our physiological and psychological state. However comfort zones can lead to a mental stagnation brought on by the fear of risk taking required to take on challenges that remove us from the zone. Fear and lack of motivation can result if we do not challenge the boundaries of the zone by avoiding exposure to stress.

Graphically we can think of a comfort zone as a circle that contains everything that we are at ease with doing inside of it. These are likely the things that are risk free and which we find easy to do. Outside of the circle are all the things that cause us stress or fear. Such things, however, are also the things that result in growth, development of new skills and new experiences. The very things that enrich life. For any individual to grow they need to challenge fears, be exposed to stress and learn to navigate the discomfort that comes with experiences outside the comfort zone.

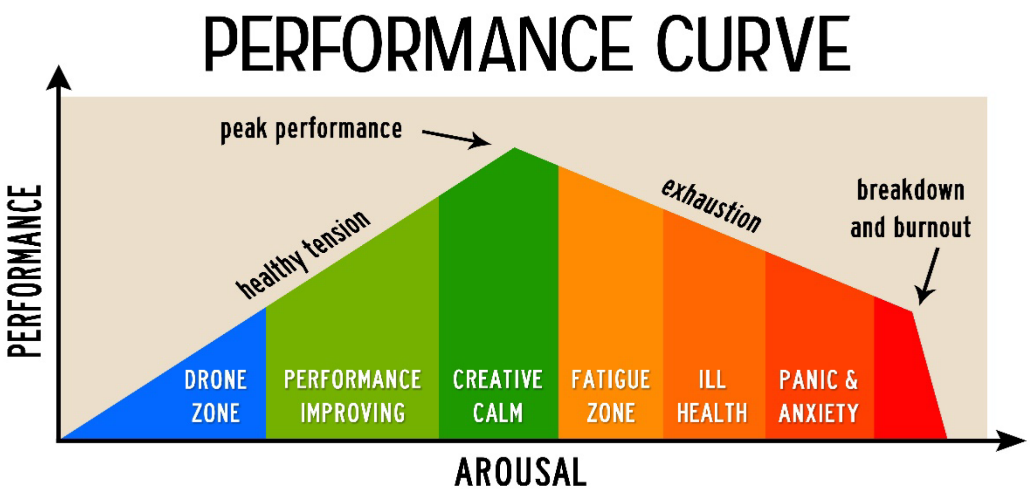


The risks assocaited with leaving the the comfort zone are perceived by us as threats and our body will respond to them in the same way it does with any other threat. However. When we challenge the threats and adapt to that stress we become comfortable with what was once uncomfortable.

Robert Yerkes and John Dodson studied the relationship between stress and performance in the early 1900s. Their empirical analysis resulted in The *Yerkes–Dodson law.* The law dictates that performance increases with physiological or psychological arousal until the arousal become too high upon which performance decreases. Confirming stress in the right doses can be beneficial (hormesis).

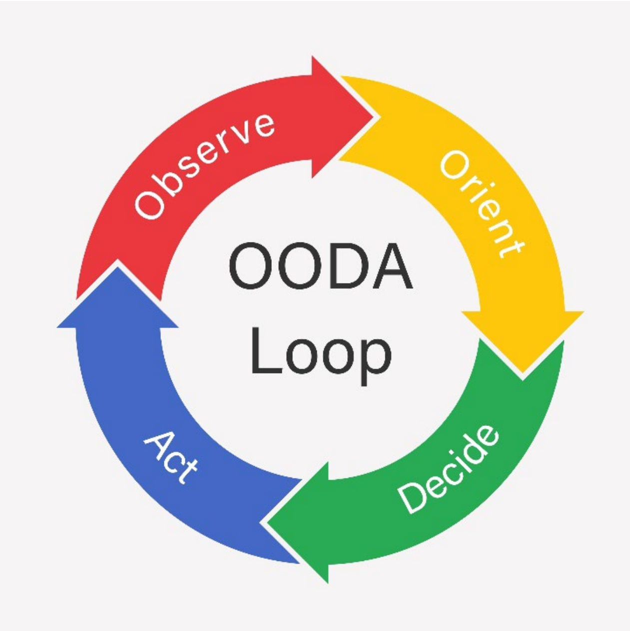
The core idea or the Yerkes – Dodson law is that our nervous system has a Goldilocks zone. Not enough arousal and we get stuck in your comfort zone and boredom takes over and with too much we enter the 'panic' zone, which can also pause progress.

The law can be graphically represented by the Yerkes Dodson Stress Performance Curve as per the below diagram.



"Insanity is doing the same things over and over again, expecting different results" – Albert Einstien

12. The OODA Loop



We can train ourselves to make better decisions when under stress by repeatedly rehearsing responses to expected situations. This repetition and rehearsal develop mental blueprints and repeatable responses that our unconscious mind can deploy during future high stress exposures (when pre-frontal cortex is shut down to allow faster decision making).

The OODA loop (Observe, Orient, Decide, Act) is a four-step decision-making process that allows us to filter available information (data), put it in context and quickly make the most appropriate decision and act. Reassessing occurs as more data becomes available and the loop continues. The phenomenon was discovered by military strategist and United States Air Force fighter pilot Colonel John Boyd. Boyd recognised the recurring decision-making pattern the occurred on both a strategic and tactical level during combat.

Boyd's main discovery was that the OODA loop was a naturally occurring process and that could be enhanced through training. Boyd's book on the subject was titled *"The fighter pilot who changed the world."* Boyd found all decision-making was a recurring cycle of observe–orient–decide–act. He concluded an entity (whether an individual or an organisation) that can process the loop quickly and repeatedly can gain tactical and strategic advantage in any situation.

Nowadays the OODA loop is applied broadly and used to understand any competitive environment. For example. Commercial and corporate environments and any structured learning processes, particularly in business, law enforcement, and military areas where sound decision making under pressure is frequently required.

12.1 Explaining the loop.

Observe.

Step one is to observe the situation with the aim of building the most accurate and comprehensive picture of it as possible.

For example, a fighter pilot might consider the following factors in a broad, fluid way:

- What is immediately affecting me?
- What is affecting my opponent?
- What could affect either of us later?
- Can I make any predictions?
- How accurate were my previous predictions?

Information alone is not sufficient so the observation stage requires converting information into an overall picture with overarching meaning that places it in context (converting it to usable data). A particularly vital skill is the capacity to identify what information is just noise and irrelevant and what s useful or relevant for the given situation and decision required.

If you want to make good decisions, you need to be a master of observing your environment. For a fighter pilot, for example makes observations of factors weather conditions and what their opponent is doing and likely to do. In a workplace, that include factors such as, regulations, operating procedures, available resources, relationships with other people and our current state of mind.

Orient

The second stage of the Loop is Orient. Which means to orientate and as Boyd said, “Orientation is a process not just a state of mind as you’re always orienting.”

Boyd referred to it as being “the main emphasis” of the loop. To orient yourself is to recognise any barriers that might interfere with other components of the OODA Loop, connecting yourself with reality and seeing the situation as it really is. You can give yourself an edge by making sure you always orient before making a decision.

Boyd maintained that properly orienting yourself will overcome an initial disadvantage, such as fewer resources or less information. The following are barriers that impact our objectivity when reviewing information.

- Our cultural traditions
- Our genetic heritage
- Our ability to analyse and synthesise
- Our ability to make sense of new information in changing environments
- Our experience with the scenario we are facing

Decide

Observe and orientate form the groundwork needed to make informed decisions and select appropriate courses of action. If there are multiple options, we need to use our observation and orientation skills to select the best one for the situation we face. Therefore, this part of the loop needs to be flexible. We should hypothetically test or mentally rehearse the decisions we make identifying any short comings prior to acting.

Act

Once we make up our mind, act. By acting we test our decision. The subsequent outcome indicates whether it was a good decision or not and provides information for when we cycle back and reassess at to the observation part of the Loop starting the looping process once more in preparation for the next action.

During training. For example. When training to deal with surfing hold downs or any other demanding scenario during which we need to make decisions on the run we can incorporate specific drills and exercises that use the OODA loop as a template for developing responses to the expected scenarios. Thereby developing sound road maps for our unconscious mind to follow when exposed to stressful and demanding situations.

38. Skilful breathing – Drills

The Full Lung Breathing drill is a fundamental drill that develops efficient and effective breathing habits by creating of greater awareness and control of your breathing. Used with nasal breathing this drill can also provide a very simple and effective relaxation tool. The drill can be adapted for use in taking a quick but solid last breath prior to a sudden breath hold. Regardless of any situation. If we can, we always want to optimise our last inhale.

1. <u>Full lung breathing</u>

- Full lung breathing – Stomach / rib / chest (2 minutes each = 6 minutes)
- Combo of S/R/C (Start Nose then switch to mouth - pursed lips and “sssss” exhales) (2minutes)

2. <u>Last breath drill</u>
    - 3 x Max (2 minute) breath holds 1 minute rest (9 minutes)
    - <u>Teaching points</u>
    - Breathe up – last 1-3 breaths via mouth (1-0-3-0) (long passive exhales / letting go tension - increases relaxation)
    - Last breath in – faster and 5 counts max - “ take a full breath with pursed lips and fully inflate the lungs from the stomach up”
    - Hold breath - Tongue lock. Block nose. Smile and relax the face. Body scan and relax the entire body. All is

39. Land - Drills

1. Walking CO2 table

Aim:

Experience the sensations of rising levels of CO2 levels in the body during exercise and become familiar with the physiological changes and mental stress associated with a strong urge to breathe.
Use specific recovery techniques to assist initiate a rapid adjustment of your biochemistry to enable preparation for subsequent Breath holds.

Description:

The walking CO2 table is a set of continuous 30 second full lung (inhale) breath hold intervals separated by a 15 second of recovery period.

How:

1. Walk continuously in a circle at an easy strolling pace.
2. Continue walking for two minutes with relaxed nasal breathing.
3. Using last breath in technique (Lessons 12) hold your Breath for 30 seconds whilst continuing to walk at a relaxed pace with your nose pinched.
4. Recovery Breathing (Lesson 13) 15 seconds and set up next last breath in whilst continuing to walk at a relaxed pace for 2 minutes.
5. After 2 minutes increase walking pace to a moderate speed.
6. Hold Breath 30 seconds whilst maintaining walk at a moderate pace with nose pinched.
7. Recovery Breathing 15 seconds and set up next last breath in whilst continuing to walk at a relaxed pace for 2 minutes.
8. After 2 minutes increase pace to a brisk walk.
9. Hold Breath 30 seconds whilst maintaining walk at a quick pace with nose pinched.
10. Recovery Breathing 15 seconds and set up next last breath in whilst maintaining walk at a brisk pace for 2 minutes.
11. After 2 minutes increase pace to a light jog.
12. Hold Breath 30 seconds whilst continuing to lightly jog with nose pinched.
13. Recovery Breathing 15 seconds and set up next last breath in whilst maintaining a light jogging pace.
14. After 2 minutes increase pace to a moderate jog.
15. Hold Breath 30 seconds whilst continuing to lightly jog with nose pinched.
16. Recovery Breathing 15 seconds and set up next last breath in whilst maintaining a moderate jogging pace.
17. After 2 minutes or when you can no longer hold the pace for the full duration of the 30 sec breath hold return to a strolling pace and relaxed breathing in and out through the nose.
18. Continue at a stroll for two minutes for until recovered.
19. Finish.

The total time for this drill is 12 minutes. Increase the pace of the walk every two minutes starting with an easy walk (approximately 4kph) ending with a moderate jog (approximately 8kph).

The drill is designed to demonstrate how CO2 accumulates in the body and how intensity increases with increases in activity. The drill gives the student an opportunity to practise recovery Breathing techniques, setting up for a last breath and maintaining awareness and control. The drill emphasises, it is rising CO2 and not dropping O2 that creates the urge to breath.

Perform this drill in a clear open space, with enough room to walk and jog in a single direction a circle or in a lineal style course.

This is a great land-based training drill. Which can be performed just about anywhere. E.g. Walking on the Beach, walking the dog or pushing a pram, etc.

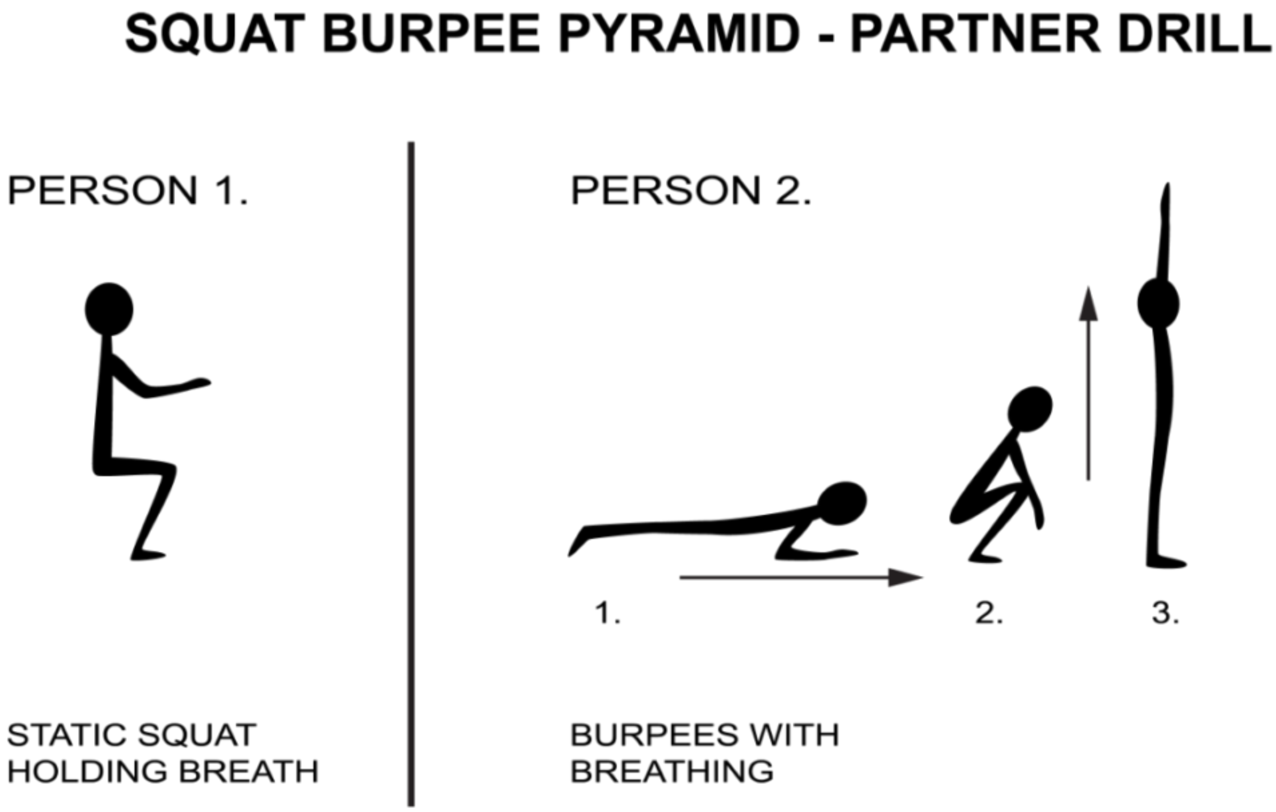
2. Burpee squat pyramid (CO2 tolerance plus teaches dynamic recovery breathing and last breath)

Aim:

- Develop CO_2 tolerance
- Create continually rising levels of CO_2 during exercise and become familiar with the physiological changes and mental stress associated with a strong urge to breathe.
- Use CO_2 tolerance recovery techniques to initiate a rapid adjustment of biochemistry and enable preparation for subsequent Breath holds.
- build

Description:

The “Squat Burpee Pyramid” is a land-based partner drill comprising of breath holding (whilst in the static squat position) and dynamic recovery breathing (whilst performing burpees).



How:

1. Person 2 starts by performing one burpee whilst person 1 adopts a static (stationary) squat position and holds their breath.
2. Once person 2 completes the first burpee they immediately hold their breath and adopt the static squat position maintaining it for the time it takes person 1 to perform their one burpee and return to the static squat position. Recovery breathing is performed during the burpee phase.
3. After both person 1 and 2 have completed their first burpee the sequence is repeated with two burpees and so on until each person has performed five burpees. This is the top of the pyramid.
4. Once both person 1 and 2 have completed 5 burpees each the process is repeated but in a descending manner, finishing once both person 1 and 2 have completed the last single burpee.
5. Burpee pyramid (1 , 2 , 3 , 4 , 5 , 4 , 3 , 2 , 1) = Total 25 burpees.

Once the entire pyramid is completed both persons walk at an easy pace for 2 minutes breathing lightly in and out through their noses only.

40. Water based drills

Drill 1 – Static Breath Hold Positions

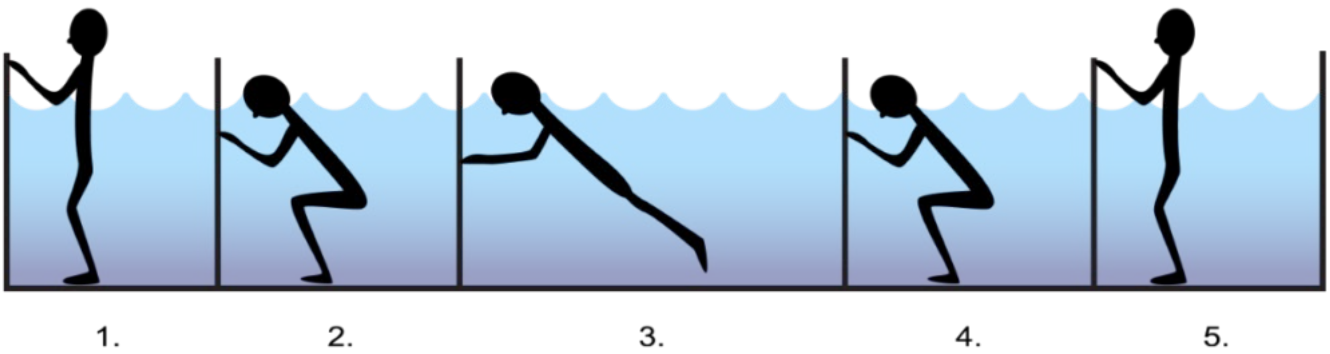
Aim:

- The static breath forms the foundation for all other breath hold drills. It allows you to discover the breath hold journey and practise our breath holding techniques in a completely controlled environment.
- Build self-awareness and self-control.

Description:

- The “Static breath hold” is our introduction to breath holding in the water. It is a fundamental drill that all other water-based Surf Apnea drills are built upon and comprises of a single stationary breath hold.
- Static Breath holds are the least physically demanding and provide an opportunity to quieten the mind, practise preparatory breathing techniques and taking of the last breath under ideal conditions with minimal stress.
- Statics also give our training buddies an opportunity to practise their observation and supervision skills.

STATIC BREATH HOLD POSITIONS



How:

1. Preparation

1. Stand in position near the pools edge.
2. Feet are shoulder width apart and positioned in contact with the bottom directly under the hips.
3. Hands are in contact with the pool coping /edge.
4. Eyes in a relaxed gaze straight ahead or closed.
5. Commence breathe up.
6. Draw your last breath in and hold.

2. Initiation

1. Once the last breath is taken. Initiate a relaxed tongue lock.
2. Bend legs lowering yourself into the water so your head is submerged.
3. Allow hands to release from coping.

3. Relaxation

1. Detach from the wall completely allowing hands, arms and legs to fully relax and float freely.
2. Relax entire body allowing yourself to allow natural relative buoyancy to occur.
3. Continue chosen relaxion technique.
4. Allow your entire body to relax and find its natural buoyancy in the water.
5. Be the water!

4. Challenge

1. Once you experience a strong urge to breath return to the start position.
2. Switch from relaxation technique to chosen mantra.
3. Face remains immersed.
4. Find the edge of the pool with your hands (buddy can help guide you).
5. Grip the edge of the pool with hands secured on the coping.
6. Bring your feet and legs in under your hips
7. Place your feet on the bottom of the pool.
8. Hold this position for the remainder of the breath hold (fighting stance).

5. Recovery

1. Once you have decided to take a breath.
2. Maintain secure grip on coping.
3. Feet on bottom of pool.
4. Extend legs.
5. Eyes open.
6. Commence recovery breathing (Lesson 13.3.2)
7. Remain in this secure position until fully recovered and you have returned to relaxed nasal breathing.

Water Based Drill 2 – Freestyle Statics

Aim:

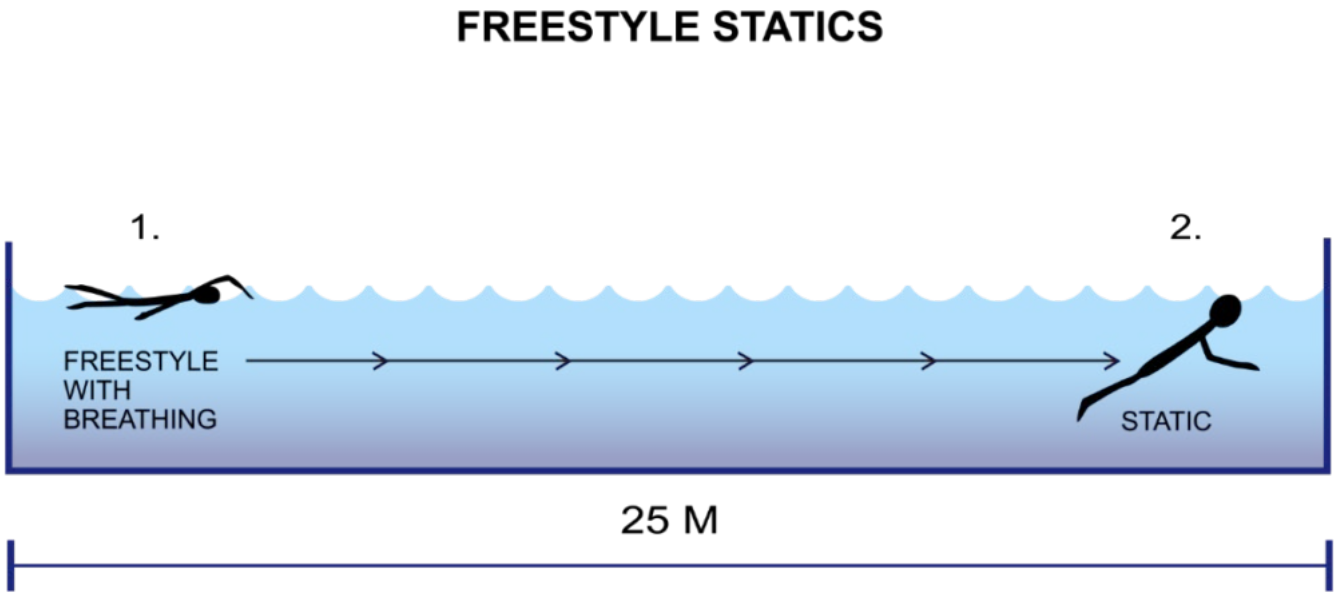
The freestyle static drill is designed to be the next progressive step from the Stationary Static drill and develops:

- CO2 tolerance
- Dynamic recovery.
- Preparatory breathing techniques
- Last breath in (whilst under a bit of pressure).
- Self-awareness and self-control.

Description:

The freestyle static drill is a progression from Water based Drill 1 static breath hold and forms the first step in preparing us to navigate a more challenging breath hold journey. All breath holds for this drill are preceded by physical activity. Meaning the recovery and preparation phases for subsequent breath holds are performed whilst there is a physical demand placed on our systems.

The drill prepares our psychophysiology for dealing with the stress of higher CO2 loads and physical exertion during rest and preparation periods. Very similar to paddling through the impact zone of a surf line up. The breath holds themselves although static will reach a point of challenging intensity in a much shorter time than with a basic Static breath hold table. Further the recovery and preparation phases are complicated by the need to keep swimming and recover from the preceding breath hold then quickly prepare for the next breath hold.



How:

The Freestyle static drill is performed by:

1. Swimming 25M freestyle at a firm (approx. 70% max exertion rate) followed immediately by
2. A static breath hold held until the strong urge to breathe is felt (70% max).
3. Upon which the breath holder swims the next 25M freestyle (breathing and recovering during the 25M of freestyle).
4. Each rep for this drill is done using a 25M distance for each swim and a 75% max breath hold after each of the 25M swims. A total of 4 rounds per set (IE 100M swimming and 4 x static breath holds in total for each rep). 1 x 25M freestyle plus 1 static = 1 rep.

The goal is to complete multiple sets of (4 x 25M lengths with 1 static performed between each 25M length). Rest between sets 1-2 minutes.

The breath holds are held until you have strong urges to breathe so they will vary in length. The first is the least stressful and longest in duration and the last breath hold will be the shorter and more intense due to the accumulation of CO_2 (which increases with more activity and time).

This is a good baseline drill for developing dynamic recovery and keeping the breath holds safe by ensuring the swimmer is loaded with CO_2 (and O_2) before commencing the holds.

Additional explanatory notes

Ideally there should be no rest following the swim phase or before talking the last breath and holding for the static phases. Nor should there be a stationary rest following the static prior to the swim phase. However, common sense prevails. Scale this drill according to your current skill level.

To work out your scaling attempt the full drill and see how you go. Examples of scaling as follows.

If you are not a great swimmer wear small rubber swim fins or reduce the swim distance to say 15 meters until your swimming improves.

If you’re not aerobically conditioned enough to maintain 75% of your max output for the full 100M reduce your output to 60 or 50% or take 2 or 3 stationary breaths before and / or after each breath hold. Or do 50M reps with 2 breath holds.

If 100M at 70% x max is not challenging enough go harder.

If 100M is not challenging enough increase the distance to 150 or 200 Meter per rep (which will also increase the number of breath holds to 6 and eight.

You may also wish to change the scaling to make your training more relevant to your specific training or operational requirements. No problem. Use the scaling guide above to progress or periodise it.

Rest periods between reps should be 60-120 seconds to allow for reasonable recovery. 4 reps per set is a good all-round base to have when plugging this drill into a training session. For example:

Rep 1
25M freestyle / static hold / 25Mfreestyle / static hold /25Mfreestyle / static hold /25Mfreestyle / static hold / Rest 60 sec

Rep 2
25M freestyle / static hold / 25Mfreestyle / static hold /25Mfreestyle / static hold /25Mfreestyle / static hold / Rest 60 sec

Rep 3
25M freestyle / static hold / 25Mfreestyle / static hold /25Mfreestyle / static hold /25Mfreestyle / static hold / Rest 60 sec

Rep 4
25M freestyle / static hold / 25Mfreestyle / static hold /25Mfreestyle / static hold /25Mfreestyle / static hold / 3-4 minutes full recovery.

How to breathe during this drill

During the first 25M of freestyle swimming breath however you would normally breathe when swimming freestyle. Some people breathe every other stroke, very three strokes etc… It's up to you.

As you swim into the spot where you will be performing the static breath hold perform a longer exhale around 5 counts then through pursed lips inhale for as long as you can on the last stroke into the static position and then hold your breath.

Hold your breath for as long as possible. Make sure you push a bit so you are experiencing strong urges to breathe. When you need to breathe begin your next 25M of freestyle. The first few breaths should be faster and more forceful both on the inhale and the exhale and through pursed lips whilst swimming.

Next settle into a nice freestyle rhythm and relax your breathing again paying attention to your distance out from the next static breath hold.

As you close in on the spot for the next breath hold, time your breathing so that you perform a couple of longer more forceful exhales (to clear out a bit of CO_2) and set up for the last inhale. Once again, the last inhale is via pursed lips and on the last stroke.

Adopt the static position and hold your breath once again for as long as you can up to 70% of max intensity. Make sure you experience a strong urge to breathe before you head off for the next freestyle lap.

Repeat until the drill is complete.

Don't get concerned about your pace or the length of your breath holds. They will both improve with time and practise.

Water Based Drill 3 – The One Breath Drill

Aim:

The freestyle static drill is designed to be the next progressive step from the Stationary Static drill and develops:

- Build CO_2 tolerance in a dynamic environment
- Improve self-awareness and self-control
- Maintain calmness under pressure using the recurring feedback loop.

Description:

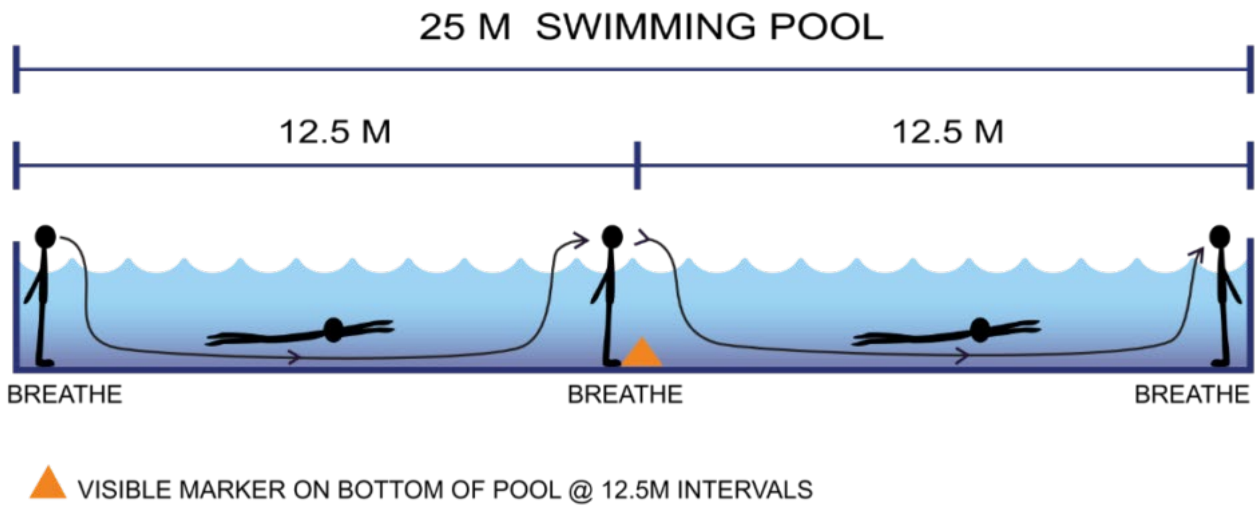
The One Breath Drill enables practise of the recurring feedback loop (Lesson 1.2) to maintain a relaxed, calm and consistent mindset, pace and stroke despite an increase in discomfort, as the urge to breath intensifies throughout this drill. Ideally the swimmer's behaviour should not change throughout this drill.

No indicators off stress should be observable despite an increase in discomfort and intensity being experienced by the swimmer. That is, the swimmer is able to remain calm and appear relaxed with their presentation (body position, stroke and breathing) not changing from start to finish of the drill.

Overtime as you adapt to the drill during future sessions work on gradually reducing the number of breaths you take during the recovery stops.

For example. Start with 5 breaths per exit and scale it according to your ability. That is, if it is too easy drop back to 3 or 4 breaths and so on. A bit of trial and error may be required to find your starting point for this drill.

The One Breath Drill is a super versatile baseline / evaluation drill. Use it as a stand-alone to keep track of progress, or in multiple sets as a training session, added to the end of a session as a finisher, or beginning of a session as a warmup.



How:

The one breath drill is performed by swimming 16 consecutive 12.5M lengths underwater using a Dynamic No Fins (frog style) stroke on a single breath for a total of 200M.

Breathe only at each 12.5M interval. Breathing is restricted to 1-5 controlled breaths per exit (scale this according to your skill level).

The drill will increase in intensity as it progresses. The idea is for you to maintain a calm mind and consistent breath, pace and stroke rate regardless of the increasing intensity.

Your stress level (exertion) should not exceed 70% of your maximum output until the last 50-75M of the 200M drill. If the intensity becomes too great to early it will impact your ability to maintain composure and compromise your ability to remain calm affecting your adaptive outcomes.

The goal is to be able to complete the entire 200M drill with only one breath per exit (every 12.5M).

Water Based Drill 4 – The Over Under Drill

The Over Under Drill is a progression from the One Breath Drill. To which we are simply adding freestyle swimming during the rest period.

Aim:

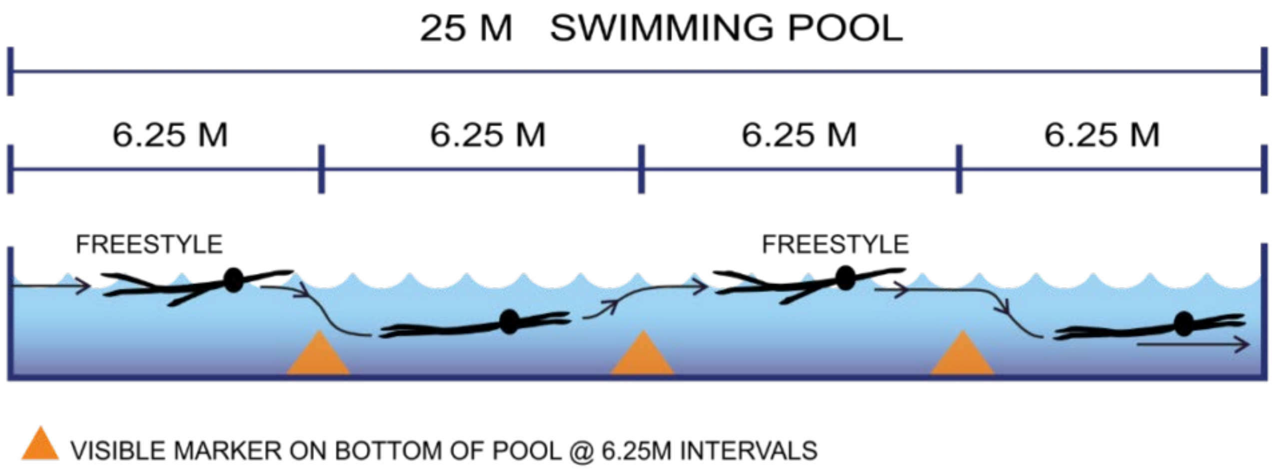
Develop:

- CO_2 tolerance
- Specific conditioning.
- Self-awareness and self-control.
- Last breath habits in an increasingly intense and dynamic environment.

Description:

The Over Under Drill is one of Apnea Survivals signature surf conditioning drill. The drill simulates a paddle out scenario where you must keep paddling (working), ducking under waves and holding your breath to negotiate the break. It teaches you to remain calm, use dynamic recovery breathing techniques to unload excess CO_2 and develop a good last breath in.

All the same principles apply to the Over Under Drill as with the One Breath Drill. That is, the drill will increase in intensity as it progresses and the idea is for you to maintain a calm mind, consistent breath and stroke rate and a solid dynamic recovery. Regardless of the drills increasing intensity.



How:

The drill is performed by swimming a total of 100M continuously using consecutive 6.25M or 12.5M lengths alternating between freestyle and underwater swimming.

The drill always starts with freestyle (over) and finishes with underwater swimming (under). Breathing is performed only during the freestyle.

Additional explanatory notes

The intermittent freestyle increases the breath holding challenge by breaking up the rhythm and requiring CO2 generating activity to be performed during the rest periods. However, this drill should not reach an intensity level beyond 70% of your max discomfort) until the last half (50%) of the drill.

You will need to focus on unloading excess CO2 during the freestyle as well as setting up the last breath before diving under. As CO2 accumulates longer more forceful but still very deliberate and controlled exhales will better manage excess CO2 accumulation prior to each underwater swim.

This drill is not about taking as many breaths as possible during the freestyle but more so, controlling and optimising the breaths you do take.

The drill will increase in intensity as it progresses and you accumulate more CO2. The goal is to build up to 100M of continuous swimming per repetition and to be able to perform multiple reps per session. The drill can be modified to cater for different ability levels. EG It can be broken down into 50M / 100M reps or 150M / 200M repeats performed at relevant intensities. EG shorter reps are performed at a higher all-out intensity with less rest than the longer reps (which have longer rest periods) with equal interval to rest.

Water Based Drill 5 – Tumble and Go Drill

The Tumble n Go Drill is Apnea Survivals signature disorientation drill.

The drill simulates the turbulence of a moderate hold down scenario where the swimmer must reorientate themselves underwater and find their way back to the surface before performing dynamic recovery and ducking under subsequent waves.

All the same principles that applied to the Over Under Drill apply to the Tumble n Go Drill. That is, the drill will increase in intensity as it progresses and the idea is for the swimmer to maintain a calm mind, consistent breathing and performance output, regardless of the increasing intensity.

Aim:

Develop:

- CO2 tolerance.
- High heart rate breath hold.
- Calm under pressure.
- Situational awareness and reorientation.
- Control under water.

- Dynamic recovery breathing techniques that unload excess CO_2.
- Solid last breath in.

The Tumble n Go Drill creates an environment that disorientates the swimmer , requiring them to use Observe Orientate Decide and Act decision making process (OODA loop), to locate the direction to swim underwater and reach the breathing position. Then transition into a quick recovery and prepare for subsequent tumbles.

Description:

Tumble position

The swimmer shall curl up as tight as possible into a ball, pulling their knees in close to their chest, with arms over their head and pull their chin to the chest. Swimmer will maintain this position whilst being tumbled.

When being tumbled it is not unusual for the swimmer to have water forced up their nostrils. This is excellent preparation for real hold down scenarios and adds a very realistic value to the drill. However, the experience for some people can be a little overwhelming. If this is the case, it is permissible for the swimmer to block their nose by pinching it with fingers or use a nose clip until they are comfortable with being tumbled. The aim is to eventually discard any need to block the nose and to get comfortable with the sensation of water shooting up your nostrils.

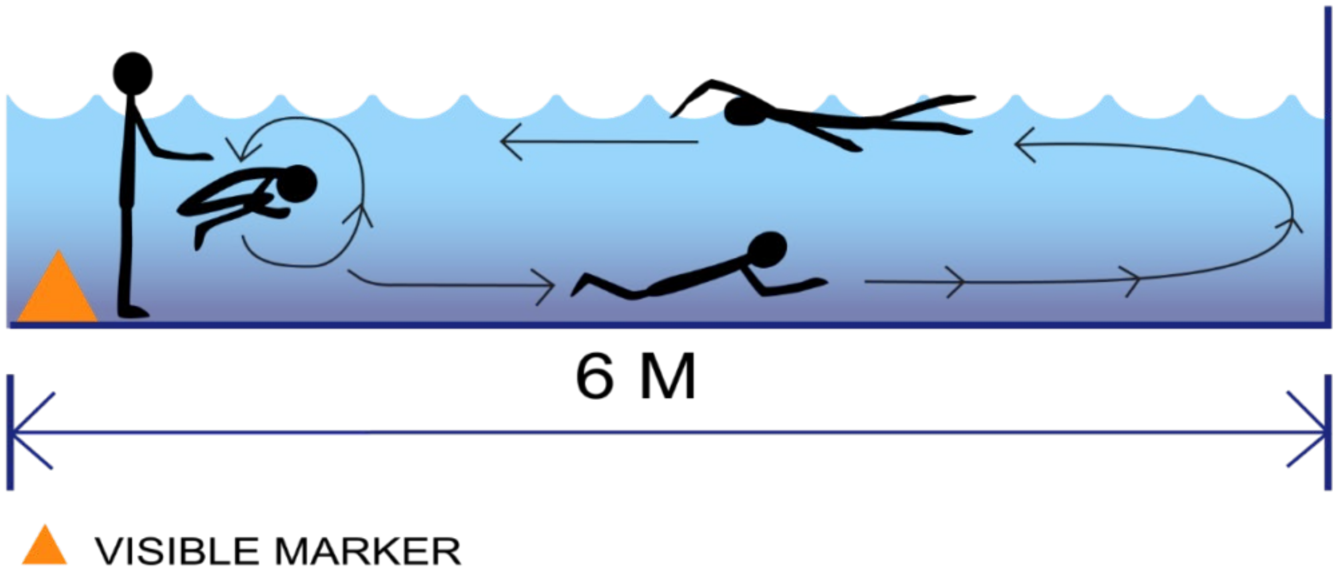
How to Tumble

The tumble is initiated with the swimmer taking a good last breath in, then curling in a ball, floating face down in the water.

1. The tumbler positions themselves adjacent to the swimmer (who is curled in a ball).
2. The tumbler places one had on the shoulder of the swimmer and the opposite hand on the hip diagonally opposite the tumblers hand which is on the swimmer’s shoulder.
3. Using a push pull method (EG simultaneously pushing on the hip and pulling on the shoulder roll the swimmer in the water.
4. Once momentum is produced it is very easy to maintain it using minimal effort or contact with the swimmer.

Master the tumbling technique by practising it with your training buddy prior to performing the drill.

O.O.D.A. DRILL V.2 (TUMBLE & GO)



Safety

Due to the intensity that can be created during Tumble n Go Drill there are several safety considerations to familiarise yourself with prior to performing this drill.

- The ‘no duff’ (emergency stop signal) for the swimmer being tumbled is indicated by ‘out stretching of the arms’. This provides a clear signal to the tumbler that the swimmer is distressed and makes it next to impossible to continue to the tumble. makes it extremely difficult for any further tumbling to occur.
- Immediately upon observing the ‘No duff’ signal the Tumbler must stop tumbling the swimmer, cease contact with them and allow them to surface unhindered (the tumbler will assist the swimmer to surface and help reorientate them once at the surface if required).
- The tumbler should check and verify the swimmer is OK and ready prior to each tumble. This is done by the tumbler verbally asking the swimmer “Are you OK?” and checking for cyanosis – bluing of the lips which indicates hypoxia).
- The swimmer will reply to the tumbler’s requested by verbally stating “I am OK” and physically present an OK signal using thumb and for fingers.
- The tumbler will confirm receipt of the swimmer’s OK signal by announcing “tumbling!”
- The tumbler must take care not to push down on the swimmer whilst they are being tumbled in water 1.2 meters in depth or less. This can cause the swimmer to impact the bottom of the pool and may result in serious injury.
- Depending upon individual conditioning levels of swimmers they may opt for an additional rest whilst performing this drill. This can be achieved by stopping momentarily once they have reached the turning wall (before commencing the recovery freestyle) and taking additional breaths as required. Or by stopping

momentarily once they have returned to the tumbler, taking additional breaths and resetting prior to any subsequent.

- As with all our drills the Tumble and Go can be scaled to accommodate any level of skill. EG add more rest or reduce the length of the tumble for less advanced folk and increase the variables for those who have more advanced skill levels.

Set up

This is a two person partner drill

Start at a lane rope or marker around 5 meters from the edge of the pool. So that the swimmer turns at the wall and returns to the tumbling (start) position at a marker or lane rope in the centre of the pool.

1. Person A starts as the swimmer (person being tumbled) and person B as the tumbler. Person A (tumbled first) will complete 4 consecutive cycles of the drill.
2. A and B alternate positions once 4 consecutive rounds have been completed by the first swimmer.
3. A single rep of this drill is completed once both person A and person B have swapped position and have both completed 4 consecutive tumbles each.

Performing the drill

1. On a full lung of air. Person A (swimmer) curls up in a ball and person B tumbles them for 10 seconds.
2. After ten seconds the swimmer is released (regardless of which position they are in).
3. Once the tumbling has ceased and the swimmer is released, they orientate themselves underwater so they are facing the toward the wall and on the same breath swims underwater to the wall (turning point).
4. At the wall the swimmer turns and swims freestyle (with recovery breathing- this is the rest period) returning to the start position where Person B is waiting.
5. Pre tumble safety protocols are performed.
6. Immediately following the safety protocols and on a full lung of air, the swimmer curls up in a ball are ready for the next tumble.
7. B tumbles the swimmer for 10 seconds.
8. And so on… repeat until four consecutive rounds are completed by the swimmer.
9. Once four consecutive rounds are completed with person A as the swimmer, A and B swap positions and the drill is repeated with person B as the swimmer and person A as the Tumbler.

End of Surf Apnea Course.

PART 2
THE BREATH FX WORKSHOP

1. Introduction.

1.1 What's in the Breath Fx Workshop?

The aim of the Apnea Survival – Breath FX Workshop is to impart the knowledge and understandings necessary for participants to use land-based breathing and breath holds to improve their health and performance and better manage stress.

The course focuses on

- Cellular respiration
- The 3 pillars of functional breathing
- Assessing functional breathing
- Breath holds to simulate altitude
- Breathing to control stress
- Cold Water Immersion
- Training drills

These notes are an accompaniment to the Breath FX Workshop Powerpoint presentation and support the topics discussed in the presentation.

1.2 What to expect.

As a result of participating in the Apnea Survival – Breath FX Workshop participants can expect to:

- Assess their psychophysiology- breathing.
- Assess their biochemistry and biomechanics.
- Hold their breath to simulate the effects of altitude.
- Develop an understanding of the breath hold journey.
- Have more skilful breathing.
- Improve their response to intense situations.
- Increase their ability to modulate your autonomic nervous system.
- Improve their ability to remain calm during stressful or intense situations.
- Develop greater self-awareness and self-control.

Safety considerations when breath holding

9. Land based training

The techniques used in this workshop are designed to be used on land and <u>are not</u> suitable for water-based training. <u>Do not</u> attempt to simulate altitude in water-based environments.

Some breathing exercises and simulated altitude training (Intermittent Hypoxic Hypercapnia Training - IHHT) may exacerbate certain pre-existing health conditions and expose some individuals to risk of black out. Ensure all participants complete the self-assessment medical questionnaire and consult with a health professional if necessary, prior to undertaking this training.

Although the drills completed in this course are relatively safe and can be performed without the aid of a training buddy, it is always advisable and preferred to have some form of competent supervision when performing breath holds and cold-water immersion. The job of the supervising training partner is to monitor the participants behaviour and respond to any circumstances that may place the participant in danger.

Safety points to consider when training in water.

15. Never perform altitude simulation drills in water.
16. Training with a competent training partner when performing simulated altitude training.
17. Know your personal limits and abilities, practice responses to black out, Loss of motor control and how to manage an emergency response.
18. Keep all training intensity to a maximum of 85% of your maximum perceived rate of exertion.
19. Monitor your O2 saturation during all simulated altitude training (IHHT).
20. Watch for signs of loss of consciousness and loss of motor control (LCM). E.G. Such as: cyanosis (blue around the lips), involuntary shaking or tremors, saucepan eyes, loss of fine motor control, loss of consciousness, sudden air loss.
21. Regularly use OK signals and requests when performing IHHT or cold-water immersion.
22. Failure of a participant to react or respond to OK or requests for OK signals during any breathing, breath holding or cold-water immersion drill may indicate that person has become hypoxic, disorientated, or has switched off their consciousness. If two consecutive OK requests have failed to solicit a response from the participant, terminate the activity immediately.
23. Place the person in a recovery position (as per your CPR training), ask them to breath only through their nose and monitor them until they are fully conscious and coherent.
24. If recovering from cold immersion, cover them with a blanket.
25. In the case of black out or loss of motor control withdraw the person from any further training immediately and have them seek medical attention from a medical practitioner forthwith, before returning to training.

Blackout

A blackout can be defined as, a loss of consciousness caused by cerebral hypoxia towards the end of a breath hold. A primary mechanism for black out is hypocapnia, followed by cerebral hypoxia (reduced CO2 in the blood and reduced O2 in the brain). Hypocapnia can cause significant delays with the feeling of air hunger (needing to breathe) and is often brought about by hyperventilation prior to the breath hold. During any black out event, the breath holder may not necessarily experience a need to breathe and may have no other obvious condition as a trigger preceding the actual black out.

Hyperventilation is sometimes used in preparation for a breath hold, in the mistaken belief it will increase oxygen (O2) saturation and make the breath hold longer. Under normal circumstances the natural, relaxed breathing rate dictated by the body, already leads to 98-99% O2 saturation of arterial blood and the effect of over-breathing on O2 intake is very minor.

Blacking or greying out near the end of a limit pushing breath hold is not uncommon during freediving competitions where competitors are attempting to break personal bests and world records, etc. However, Black outs should be avoided completely during training and at a recreational level. The most current thinking on the topic, has identified blacking out may result in Central Nervous System trauma (fear perceptive memory) which can predispose the breath holder to greater risk of future black outs, create performance barriers and cause training setbacks. This is due to *fear perceptive memory*, whereby the body and brain attempt to prevent the traumatised person from revisiting the place (mentally or physically) where the original injury occurred.

1. Avoiding a black out

Blackout can occur when a participant has pushed the extreme limits of their breath holding capacity and depleted their cerebral O2 saturation. Black Out can be avoided by ensuring that CO2 levels in the body are maintained prior to a breath hold and that appropriate safety measures are in place. This can be achieved by the following:

10. Taking time prior to the breath holds to relax and allow blood O2 and CO2 levels to reach their natural equilibrium.
11. Prior to any breath hold use your normal relaxed breathing rate and depth and allow your body to dictate the rate of breathing to ensure CO2 levels are properly calibrated.
12. Use relaxation techniques to extend your relaxation time, which will extend your breath hold time.
13. Develop your breath hold abilities gradually and progressively.
14. Get formerly trained (certified) in the techniques you are using.
15. Always train with a competent buddy.
16. Never push breath holding limits beyond 85% of your max.

2. Response to blackout.

16. Lay the breath holder on the ground.
17. Remove any hats, fascial coverings, sunglasses, goggles, etc.
18. Roll the breath holder onto their side and into a recovery position as per your CPR training response for an unconscious breathing person.
19. Repeatedly call the breath holders name and instruct them to breathe. Eg, “Breathe - *Name of breath holder* - breathe!”
20. Simultaneously blow air across their cheeks and / or gently tap them on the check with a hand (this helps stimulate breathing).
21. Once the breath holder regains consciousness provide O2 therapy if available, maintain continuous observation and seek medical assistance.
22. If the breath holder does not respond within 45 seconds begin rescue breaths and / or rescue

procedures as per whatever CPR training you have received for an unconscious, non-breathing patient.

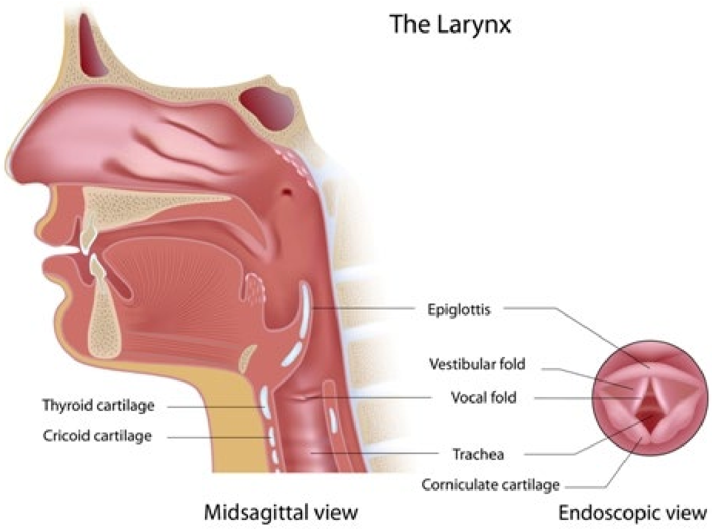
23. Call out for / seek assistance.
24. NOTE: Be aware of the "Laryngospasm" – This is when the epiglottis and vocal cords spasm shut and seal off the airways to prevent material entering lower airways and lungs. The release of this spasm is triggered by rising levels of CO_2 and may take 45-60 seconds after an event to occur. Be aware the breath holder cannot breathe until the spasm has relaxed.
25. The breath holder should not train again until cleared by a medical practitioner. A four-week period before returning to breath holding is the general rule following any loss of consciousness.
26. Practice and be prepared to respond to medical emergencies and undertake training in First Aid, CPR / Advanced resuscitation / AED (Automated external defibrillator).
27. Ensure you or your training venue has functioning, up to date, emergency life support equipment such as, Oxygen, AED (defibrillator), etc. Know where it is located and familiarise yourself with it prior to conducting any training at the facility.

NOTE: <u>ALWAYS</u> seek medical advice following any black out event.

3. Laryngospasm

Laryngospasm refers to a sudden spasm of the vocal cords. The spasm can be a symptom of underlying conditions including anxiety, stress, or the *entry of water into the larynx or trachea* (windpipe). Laryngospasm can occur following black out or when a person attempts to take a breath at the same time foreign material, unexpectedly enters the upper airway (trachea or larynx). At this moment an involuntary reaction occurs, during which the epiglottis and vocal cords close rapidly to seal off the windpipe and prevent ingress of foreign matter into the lungs.

When experiencing a laryngospasm people report feelings of choking and an inability to breathe. The spasm can occur in both conscious and unconscious people and is not uncommon in submerged blackout victims. Although quite stressful (when experienced when conscious) the spasms generally last only 5-10 seconds. Laryngospasm can be treated by holding your breath for around 10 seconds allowing CO_2 levels to rise. The subsequent rise in CO_2, is one of the things that can trigger the release of the spasm. To recover from the laryngospasm, breathe in and out slowly, *<u>through your nose,</u>* keeping the mouth closed. If too challenging, inhale through the nose and slowly exhale through pursed lips.



4. Cyanosis

Cyanosis is the change of body tissue colour to bluish-purple as a result of decreased O2, bound to hemoglobin in the red blood cells of the capillaries. Body tissues presenting with cyanosis are generally at locations where the skin is thinner. Such as, lips, nail beds, and ear lobes. Cyanosis is often due to a circulatory or ventilatory problem (reduced O2), that leads to poor blood oxygenation in the lungs. It develops when arterial O2 saturation drops below the 85% to 75% range.

5. Loss of motor control (LMC) / Samba

Loss of motor control (LMC) AKA Samba is a series of muscle twitches caused by low O2 levels in the body. LMC can be a minor tremble and a brief event or violent convulsions, progressing to unconsciousness.

Indicators of LMC include:

1. Trembling
2. Convulsions
3. Confusion
4. Difficulty breathing
5. Lack of responsiveness,
6. Loss of bladder control and
7. Cyanosis (blue lips).
8. Saucepan eyes

Avoid LMC in training by extending land-based breath hold times gradually and never beyond 85% of your maximum ability. Do not push limits prematurely. It takes time for your body to adjust and adapt.

6. Response to loss of motor control (LMC)

1. Sit the breath holder down in a comfortable position.
2. Remove any hats or fascial coverings, sunglasses etc.
3. Hold the breath holder upright.
4. Repeatedly call the breath holders name and instruct them to breathe. EG, "Breathe - *Name of breath holder* - breathe!"
5. Simultaneously, visually imitate how you want the breath holder to breathe (this helps stimulate breathing).
6. Once the breath holder regains consciousness provide O2 therapy if available, maintain continuous observation and seek medical assistance.
7. If the breath holder does not respond within 45 seconds begin rescue breaths and / or rescue procedures as per whatever CPR training you have received for an unconscious, non-breathing patient.
8. If the LMC progresses to black out – follow black out protocol.
9. Call out for / seek assistance.
10. The breath holder should not train again until cleared by a medical practitioner.
11. Practice and be prepared to respond to medical emergencies and undertake training in First Aid, CPR / Advanced resuscitation / AED (Automated external defibrillator).

2. Ensure you or your training venue has functioning, up to date, emergency life support equipment such as, Oxygen, AED (defibrillator), etc. Know where it is located and familiarise yourself with it prior to conducting any training at the facility.

Lesson Two – Breathing.

2.1 Why we breathe.

"Why do we breathe?"

- Humans are aerobic beings. They rely on aerobic respiration to survive.
- Oxygen (O2) is required for aerobic respiration (production of energy).
- Metabolic by-products such as carbon dioxide (CO2) need to be removed from the body.

Respiration is the movement of gas across a membrane. For example, gas exchange in the lungs is referred to as external respiration. A thin membrane called the respiratory membrane allows gas to cross and separates air within the alveoli from blood within pulmonary capillaries.

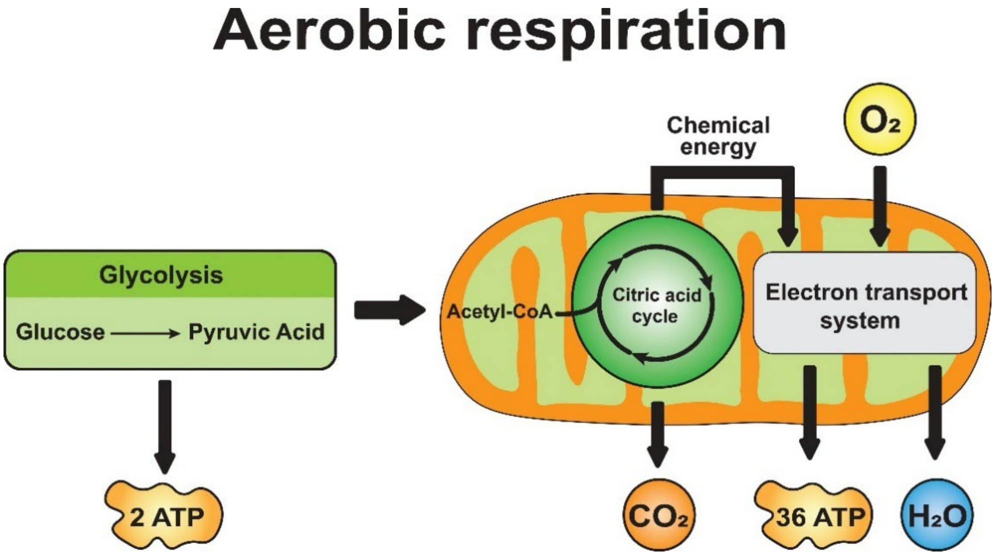
After a couple of minutes of activity your body's cells use the O2 you've inhaled to obtain energy from the food you eat. This process is called *aerobic respiration.* During *aerobic respiration* cells use O2 to break down sugar (from the food we've consumed) initiating the multistage aerobic process.

The breaking down of the sugar produces the energy we need to contract muscles which enables us to do the things we want our bodies to do. Carbon dioxide (CO2) is produced during aerobic respiration. This CO2 is subsequently removed from the body by dissolution (dissolving) after combining with another aerobic respiratory by product, water (H2O) and forming carbonic acid (H_2CO_3). CO2+H2O = H2CO3.

In solution the CO2, is able to make its way into the blood stream where it binds with haemoglobin (Haldane effect) to be transported to the lungs via diffusion, for exhaling out of the body via the airways.

In a nutshell aerobic respiration is the body's ability to transport O2 from the lungs into the mitochondria of the cell and produce a very important energy source called ATP (adenosine triphosphate). ATP is then used by the body as an energy source to drive a variety of processes, including muscular contractions. The body can operate without O2 (anaerobic respiration) but only for very short periods of time.

Anaerobic respiration is a form of energy production occurring in the absence of O2. However, although humans have this capability it is inefficient and very short lasting. Human bodies are not built to maintain perpetual and ongoing anaerobic respiration, as it is super taxing and cannot be sustained or replenished for a significant period of time.



Primary functions of breathing

1. Biomechanical

- Refers to the actions of the neuromuscular respiratory pump (NRP)
- Creates changes in the intra-abdominal and intra-thoracic pressure that drive the movement of air, lymph and blood

Note: The neuromuscular respiratory pump (NRP) refers to the central nervous system control centres and feedback mechanisms, spinal cord, motor nerves, and the respiratory muscles, that affect chest-wall and lung movement, causing air to enter the lungs and CO2 to be excreted into the environment.

2. Biochemical

- Refers to its effect on blood gases and body chemistry

Secondary functions of breathing

Breathing plays a very important role in non-respiratory functions including the following:

- Psychophysiology - self-regulation of mental and emotional states
- Speech and vocalisation
- Homeostatic rhythms and oscillations
- Spinal stability, posture and motor control

2.2 Our Breathing impacts everything about us

Breathing is the ventilation of air in and out of the body. Breathing has other functions apart from solely supporting aerobic respiration.

Ventilation is a single breath cycle (one inhale and one exhale). I.E. The physical movement of air to and from the environment outside our body, in and out our lungs. Air enters the body via the airways (mouth and nasal passages) before heading down the pharynx. At the vocal cords, it flows into the trachea and eventually into the lungs, passing through various branches of bronchioles and eventually arriving in the alveoli. This is inhalation. Air moving in the reverse direction is exhalation. Inhalation followed by exhalation equals one ventilation (or one breath cycle).

The way we breathe can impact every function in our body and mind. For example.

- Gas levels - O_2 and CO_2 levels in the body.
- Nitric Oxide (NO) production in nasal cavity. NO has many important biological functions including relaxing walls of blood vessels, vasodilation (widening of the vessels). This increases blood flow to the heart and other organs. NO also acts as a signalling molecule between nerve cells and plays an important role in our immune system and fighting infections.
- Motor control and postural stability and plays several roles in physiological and psychological regulation (mind - body connection).
- Maintaining homeostasis in systems such as:

    10. Emotions
    11. Heart Rate
    12. Heart Rate Variability (HRV)
    13. Vagal toning (vagus nerve function)
    14. Autonomic nervous system (Parasympathetic and Sympathetic regulation)
    15. Circulatory system
    16. Digestive system / Enteric nervous system
    17. Chemical regulation
    18. Metabolism (energy production).

In a nutshell the way we breathe affects the function of all other systems in our body. Including how well we prepare for and recover from a breath hold. If your breathing is crappy your performance is going to be the same. Crappy!

2.3 Recurring Feedback Loop

(The mind / body / breath connection)

The *recurring feedback loop (RFL)* is a circular repeating cycle of communication between the Mind, Body and Breath. Each can affect the other and each can be manipulated involuntarily or voluntarily. Being aware of the involuntary reactions of the RFL, enables us to regain control through voluntary manipulation of any of the three components. IE. If you notice your breathing has changed (E.G. short fast chest breathing) you can adjust your movement by slowing it or thinking using self-talk, to bring it back under control.

The RFL is part of our in-built survival system, that works by allowing any one or combination of the components (mind / body / breath) to send information in any direction which is then used to influence our behaviour and responses to whatever events we are exposed to.

For example. Let's use the scenario of being out in waves large enough that you don't really want to be caught in the impact zone with waves breaking on your head. IE. Surf conditions challenging enough that you experience heart flutters and hesitation when negotiating the break. For whatever reason, you find yourself bobbing around in the impact zone and when you look out to the horizon you notice some huge lines feathering and stampeding their way toward you. You know, from your past experience, in these situations that these walls of water are going to break before they pass you and very likely right on top of you.

One of the first things that will happen is that your breathing will change. Shallower, faster and higher into the chest, as your body attempts to increase your heart rate and ramp up your energy to prepare you to "fight" or "flee" the perceived threat. If this change in breathing is left to escalate, your heart rate will increase, your stress response will ramp up, adrenaline and cortisol will be dumped into your blood stream and your amygdala will hijack your ability to think rationally.

However, this scenario can be controlled once you recognise any of the cues, associated with the activation of the stress response, such as, the change in your breathing and then intercept the change by controlling your breathing. EG. Focussing on long slow controlled exhales. This send a message through the RFL to the brain that you have control of the situation. This results in a down regulation of the stress response.

Note: regardless of any the threat in front of you. Whether it's a large wave, whirlpool, mad person with a gun, speeding car or whatever, your body will naturally respond in the same way regardless of the threat. Caveat – Unless you have deliberately trained in behavioural responses to specific scenarios.

Lesson Three - Psychophysiology

Psychophysiology is psychology that is concerned with the physiological bases of psychological processes. The following drill demonstrates how powerful breathing is and how easy it is to impact our psychophysiology, simply by changing the way we breathe.

The drill consists of 1 minute voluntary hyperventilation (superventilation) followed immediately by 1 minute nasal only breathing and is performed as follows.

3.1 The psychophysiology drill.

13. Lay flat on your back on the floor or sit relaxed and comfortable.
14. Breathe only through the nose using your natural breath cadence to relax.

15. Continue for 2 minutes
16. After 2 minutes.
17. Purse your lips and inhale with as much force and as hard as you can. Followed by an exhale in the same manner. Repeat at a breath rate as fast as possible around 1 breath cycle (inhale + exhale) per second.
18. Continue for 1 minute, focussing on what sensations you're feeling and what emotions you're experiencing.
19. After 1 minutes. Return to a naturally paced nasal only breathing. Breathe in and out, softly and quietly and in a calm, controlled manner through the nose only. Close your eyes if you feel like closing them. Pay attention to what sensations you are feeling and what emotions you are experiencing and how your feelings compared to the previous superventilation technique.
20. Continue for 1 minute.
21. After 1 minute take a couple of natural breaths, have a stretch and get up and move around.

WARNING: If you feel any dizziness, pain or severe tingling or disorientation during any of the exercises or drills in this course. Cease immediately. Sit or lay on your side in a comfortable position and allowing yourself to return to your natural relaxed breathing rate and pace.

Now let's have a look at what was going on during this drill.

3.2 What happens during superventilation.

Superventilation is controlled hyperventilation. Hyperventilation is breathing (ventilation) which exceeds our metabolic demands. The superventilation you performed may have resulted in you experiencing any or a combination of the following classic symptoms associated with hyperventilation:

- Dizziness
- Light headedness
- Physical weakness
- Shortness of breath
- Unsteadiness / loss of balance
- Muscle spasms / cramps (extremities)
- Tingling sensations (mouth and fingertips)
- Increased heart rate
- Feeling confused
- Feeling anxious
- Feeling stressed
- Feelings of depersonalisation (non-reality / dream-like)
- Loss of focus and concentration
- Impaired memory
- Hallucinations
- Blurred vision
- Tunnel vision

- Flashing lights
- Seeing multiple
- Saw ribs and breathing anatomy
- Changes in blood pressure
- Wheezing (Bronchi constrict to restrict loss of CO_2 – sports asthma)

Hyperventilation creates a rapid lowering of CO_2 levels in our blood, which causes a narrowing of the blood vessels (vasoconstriction), that supply blood to the brain and tightens the bond between haemoglobin and O_2. Reducing its availability at a cellular level.

This reduction in blood supply to the brain and O_2 to the cells leads to many of the symptoms listed above, which are all characteristics associated with the stress response. Continued hyperventilation can lead to loss of consciousness.

Note: Contrary to popular belief hyperventilation does not over oxygenate the body or increase O_2 concentration. Rather it causes an excess dumping of CO_2 and reduces O_2 supply to the brain and cells. Hyperventilation can make us feel very uncomfortable, uneasy and stressed and may create feelings of losing control.

Note: Hyperventilation upregulates the sympathetic nervous system and can form part of our stress response, during which the body is dumping CO_2 to prepare to fight or flee from a threat.

3.2.1 Mouth Breathing

Involuntary mouth breathing, is a dysfunctional breathing trait, associated with hyperventilation and it can also be hyperventilation in and of itself. The following occurs when we breathe using our mouth.

- Rapid unloading of CO_2
- Increased hypocapnia (negates the Bohr effect)
- Reduces cellular oxygenation
- Increased CO_2 sensitivity
- Air enters lungs unfiltered / unconditioned (causing allergic reactions, irritation and inflammation)
- Exercise induced Bronchoconstriction (sports asthma)
- Increases sympathetic toning (fight or flight)
- Triggers stress response (HPA Axis)
- Biochemical imbalance
- Biomechanical imbalance
- Psychophysiological imbalance
- Decreases movement efficiency and spinal stability
- Increased heart rate
- Increased breath rate
- Loss of humidity (dehydration)
- Confusion
- Anxiety
- Stress / concern
- Poor sleep / snoring

- No Nitric Oxide

Note: Hyperventilation and mouth breathing increase sympathetic toning (Fight or Flight response) / stress.

3.3 What happens during nasal breathing.

When nasal breathing we may have experienced any or all, of the following:

- Effortless breathing
- Reduced breathing cadence (your breathing slowed down)
- Longer inhale
- Longer exhale
- Feeling of calm
- Feeling of relaxation
- Closing of your eyes
- Light abdominal centric breathing
- Increased self - awareness
- Increased self-control
- Improved mental clarity
- Improved vision
- Improved hearing
- Improved focus
- Slowed heart rate
- Increased parasympathetic (rest and recovery) toning

Slow controlled nasal breathing sends a signal to our brain and body's systems, that we are in control and that everything is OK. This messaging activates greater parasympathetic (rest and recovery) toning and down regulates the sympathetic nervous (fight or flight) system, rebalancing autonomic homeostasis. Increased parasympathetic dominance improves relaxation, reduces stress, improves circulation, restores our ability to rest and sleep, reduces allergies, decrease sinus congestion, improves cognitive ability, improves focus, enhances physical performance and down regulates stress.

Practising slow nasal breathing regularly, produces significant improvements in our physical, cognitive and mental health and overall well-being.

Benefits of Nasal Breathing:

- Humidifies, Filters + warms/cools air
- Increases air flow to arteries, veins, and nerves
- Increase O2 uptake and circulation
- Reduces sensitivity to CO2
- Slows down breathing
- Improves lung capacity and vitality
- Strengthens the diaphragm

- Reduces the risk of allergies
- Reduces your risk of asthma
- Aids your immune system
- Reduces snoring and sleep apnea
- Improves oral health
- Reduce tension and stress (Parasympathetic activator)
- Vagal nerve activation
- Enhances facial / dental development (straight teeth / square jaw)
- Prevents overexertion
- Improves recovery from illness and exercise (stress)
- Improved defence against viruses and bacteria as initiation of this process takes place in the nasal cavity (common cold)
- Microscopic fluid sacs produced during nasal breathing kill bacteria and reduce virus invasion.
- Produce Nitric Oxide – Carried to body via nasal breath
- NO - conditions vessels, tissues, combats bacteria / virus, regulates blood pressure, assists in O_2 delivery & boosts immune system.
- Increased tolerance to CO_2 / Increased O_2 delivery increases vitality.
- Altitude training affect
- Athletic performance
- Humidifying
- Improves deep and REM sleep
- Improves daytime energy levels
- Improves Nitric Oxide levels and circulation in the body

NOTE: In aquatic environments and when recovering from and preparing for long or intense breath holds it may be more appropriate to used controlled mouth breathing.

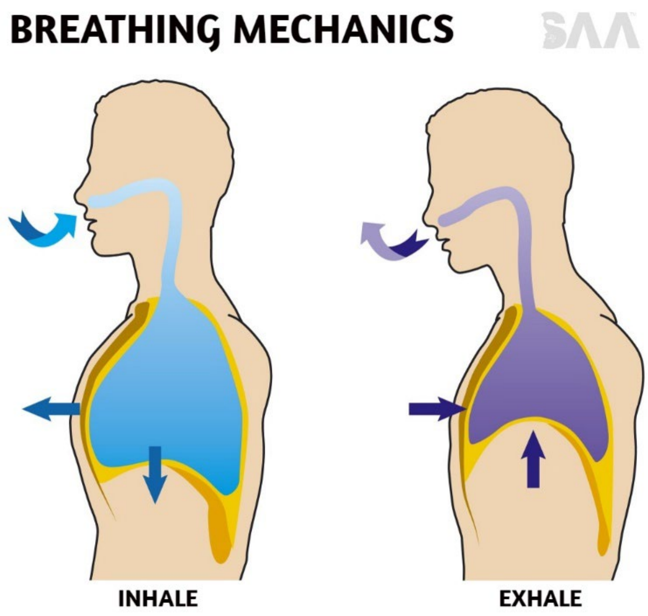
Lesson four – Breathing physiology.

Inhalation and exhalation create a gas turnover in the lungs. CO_2 that has accumulated in the body, as a result of metabolism, is carried from tissues in the blood back to the lung, where diffusion moves it from the blood to the air spaces in the lungs, after which it is expelled by exhalation via our airways. The Haldane Effect explains the process that enables CO_2 to be eliminated. Vice versa O_2 rich air enters the body via the airways into the lungs and diffusion transfers it into the body's tissues. The Bohr Effect explains the process of O_2 disassociating from haemoglobin.

An understanding of both the Haldane and Bohr effect is useful as these processes are impacted by the way we breathe. The efficiency of both these processes impacts our ability to prepare and recover for and from breath holds. Understanding this emphasises the importance of optimising breathing techniques to optimise breath holds.

4.2 Gas exchange in the human body.

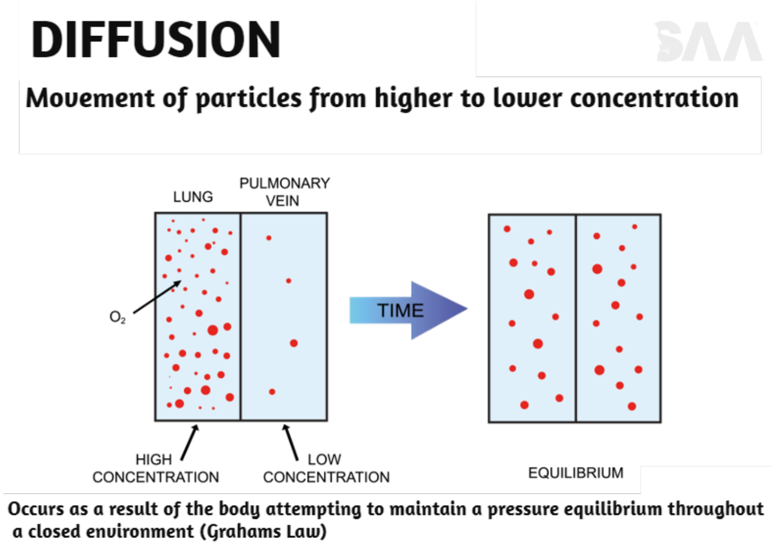
4.2.1 How air gets into the body.



The diaphragm is a thin muscle that sits at the base of the chest and separates it from the abdomen. When you inhale your diaphragm contracts and pulls downward increasing the space (volume) in and around your lungs, allowing them to expand. The muscles between your ribs (intercostals) also play a significant role to enlarge the chest cavity. They work to pull your rib cage upward and outward when you inhale, again increasing the space in which the lungs can expand. As the diaphragm contracts and the thoracic cavity space increases, the pressure inside the lungs is reduced to the point where it is less than the atmospheric pressure outside of your body. This creates vacuum effect, which draws air into the lungs(area of lower pressure) via the airways from outside the body (area of higher pressure).

When you exhale, your diaphragm relaxes upward, reducing the space in and around the lungs decreasing the lung volume. The intercostals also assist by contracting the rib cage. This process increases the internal pressure of the lungs to a point where it is greater than the air pressure outside the body and causes air to move out of the lungs via the mouth or nose to the surrounding atmosphere of less pressure.

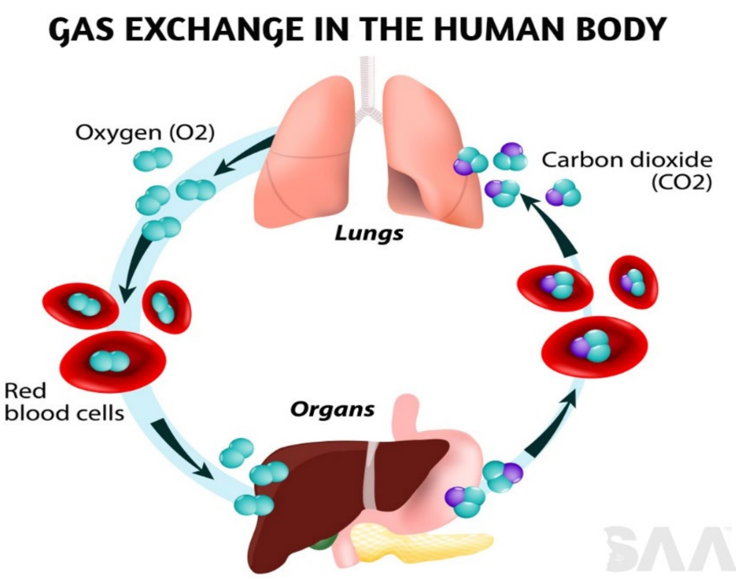
4.2.2 Diffusion



Diffusion is the process by which gases are transferred from the air we inhale via the lungs into the circulatory system for transportation to tissues and organs. Diffusion occurs because of a gas attempting to maintain a pressure equilibrium throughout a closed environment (Grahams Law).

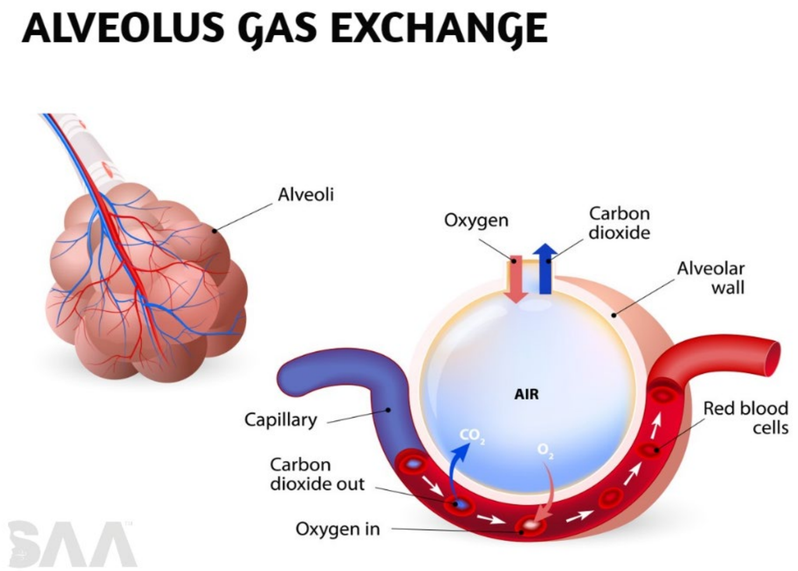
The higher the pressure exerted upon a gas the greater ability of that gas to diffuse. In a closed system, pressure and temperature are directly related, in that the higher the temperature of the closed space the greater the pressure and the more easily a gas will diffuse and vice versa. This is caused by the gas contained in that space "wanting" to maintain an equal pressure across all permeable portions of the closed system in which it exists.

If there is a position of higher pressure then a gas will diffuse to an area of lower pressure to maintain a pressure equilibrium across both regions. Pressure increases the number of particle collisions thus increases the rate and speed of diffusion. It is this process that allows gases like O2 and CO2 to move in and out of the body.



In the context of breathing and breath holding gas exchange refers to the movement of O2 into the blood and CO2 out of the blood. O2 and CO2 move across the respiratory membrane. O2 moves out of the alveolus into the capillaries while CO2 moves in the opposite direction from the capillaries into the alveolus.

Gases are exchanged between the alveolar air and the blood using the process of diffusion. IE a result of the movement of molecules from an area of higher concentration (greater pressure) to an area of lower concentration (lower pressure).   The rate of diffusion can be influenced by a variety of variables. Such as, atmospheric pressure and the magnitude of the concentration gradient of the diffusing substance.

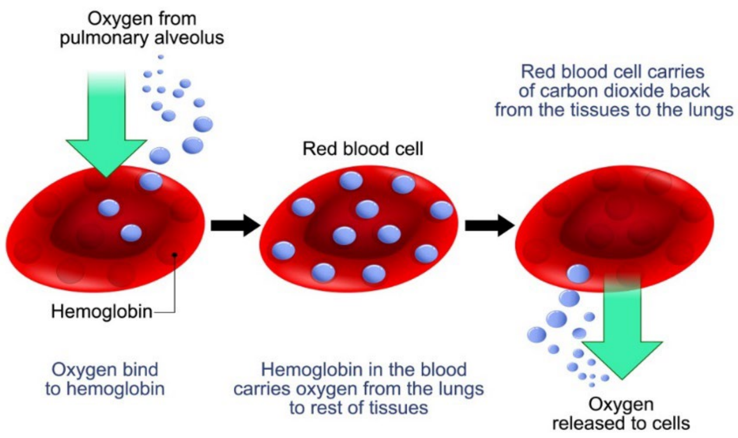


Points to remember:

- Diffusion results from a body or substance attempting to maintain a pressure equilibrium throughout a closed environment.
- The efficiency of diffusion in your body impacts the availability of O2 for use at a cellular and cerebral level.
- Diffusion will cease once a pressure equilibrium is reached.
- Increased pressure = enhanced diffusion

4.2.3 Bohr effect

The *Bohr effect* explains the physiological phenomenon first described in 1904 by the Danish physiologist Christian Bohr and refers to the observation that increases in the CO2 partial pressure of blood (decreases in blood pH /higher acidity) result in a lower affinity of haemoglobin for O2. This is due to the difference in pH between the cells of the body and haemoglobin. Hence the presence of CO2 is required to maintain the movement of O2 from haemoglobin in the blood to the cells and tissue.



4.3 Nitric Oxide (NO)

Nitric oxide (NO) is a colourless gas that is formed by the oxidation of nitrogen. Although toxic at high concentrations, nitric oxide functions as an important signalling molecule in humans. Acting as a messenger, transmitting signals to cells in the cardiovascular, nervous, and immune systems. Due to its importance in neuroscience, physiology, and immunology, nitric oxide was proclaimed "Molecule of the Year" in 1992.

The nitric oxide molecule's possession of a free radical makes it much more reactive than other signalling molecules, and its small size enables it to diffuse through cell membranes and walls to perform a range of functions in variety of the body's systems. The body synthesises NO from the amino acid L-arginine by means of the enzyme nitric oxide synthase.

The main site of the molecule's synthesis is the inner layer of blood vessels (the endothelium, a single layer of cells that lines the interior surface of blood vessels and lymphatic vessels). NO diffuses to underlying smooth muscle cells and causes them to relax. This relaxation causes the walls of blood vessels to dilate increasing blood flow through the vessels and decreasing blood pressure. Nitric oxide's role in dilating blood vessels makes it an important controller of blood pressure.

NO is also used by the nervous system as a neurotransmitter, to regulate functions such as digestion, blood flow, memory and vision. In the immune system NO is produced by macrophages (a type of white blood cell) that overwhelm bacteria, parasites, tumour cells and other foreign particles that enter the body. NO kills bacteria, etc by disrupting their metabolism.

NO is essential to obtain an erection of both the penis and clitoris. During sexual stimulation, NO released within the sexual organs relaxes the smooth muscle cells, making it easier for blood to flow in and expand the spongy tissues which hardens and elevates the organ. It also contributes to vessel homeostasis, by inhibiting vascular smooth muscle contraction and growth, platelet aggregation, and leukocyte (white blood cell) adhesion to the endothelium. Humans with diabetes, atherosclerosis or hypertension often show impaired NO pathways. NO also effects cardiac muscles by decreasing contractility and heart rate and contributes to the regulation of cardiac contractility. Emerging evidence suggests that coronary artery disease is related to defects in generation or action of NO.

By holding the breath for short periods of time or breathing slowly and lightly NO accumulates in the nasal cavity. When we resume breathing, following the breath hold, if we breathe in, we will carry NO from the nasal cavity into the lungs. Both NO and CO_2 play an important role in opening the airways, improving blood circulation and allowing more oxygen to be delivered to cells. Upon reaching the lungs NO diffuses into the blood and lungs helping to reduce stress, asthma symptoms and recovery of the breath following physical exercise.

Healthy nasal breathing is vital, as it allows the body to utilise NO to expand the blood vessels. It was not until the 1980s that the many benefits of nitric oxide (NO) were fully understood. In the mid-1990s, scientists discovered that NO was being produced in the paranasal sinuses (a group of four air-filled spaces surrounding the nasal cavity). As we breathe in through the nose, NO is released into the nasal airways. NO is constantly being released in our nasal airways as we breathe. As a breath is taken in through the nose, nitric oxide will follow that airflow down into the lungs for the purpose of increasing the amount of oxygen uptake in the blood. The NO, then follows the airflow to the lungs, where it does many things including opening of the airways and increasing O_2 uptake in the blood.

In a nutshell NO:

- Produced by nasal breathing
- Improves heart function, blood pressure, immunity, cognitive function
- Decreases inflammation
- Improves cellular oxygenation
- Aids in weight loss
- Improves digestion
- Decreases anxiety and depression
- Decreases neuropathic pain
- Improves erectile dysfunction
- Decreased NO reduces cognitive and heart function, immunity, increases blood pressure and chronic inflammation

Lesson Five – Pillars of functional breathing.

5.1 What is functional breathing

"Function breathing is, breathing that efficiently and appropriately performs its primary and secondary functions. Functional breathing is not static or fixed, it changes according to the conditions" – Rosalba Courtney

Traits of function breathing are responsive to the changing needs of an individual and can be described as follows:

- Does not contribute to symptoms and pathology E.G movement dysfunction or pain
- Efficient
- Adaptive
- Appropriate
- Responsive
- Supportive

DEAARS – "Functional breathing has DEAARS"

5.1.2 What is dysfunctional breathing.

"Dysfunctional breathing, is breathing that does not efficiently fulfil the primary or secondary functions of breathing." – Rosalba Courtney

Dysfunctional breathing does not have DEAARS and is not responsive to the changing needs of the individual.

- Dysfunctional breathing can contribute to symptoms and pathology. Such as, movement dysfunction or pain
- Not Efficient
- Not Adaptive
- Not Appropriate
- Not Responsive
- Not Supportive

Dysfunctional breathing patterns are multi-dimensional and made up of a combination of biochemical, biomechanical and psychophysiological components. As a result, a comprehensive breathing screen is required to enable accurate identification of any dysfunctional breathing.

The ability to hold your breath, is seen as a function that is impacted by dysfunctional breathing and an inability to hold your breath following an exhale, for more than twenty seconds is a reasonable indication that breathing pattern dysfunction is present. Resting CO_2 levels are also generally accepted to correlate with your breath hold time.

5.2 The Pillars of functional breathing

The pillars of functioning breathing provide us not only with a reference to the three elements that impact breathing (and which are also impacted by our breathing) but also with parameters to identify dysfunctional breathing.

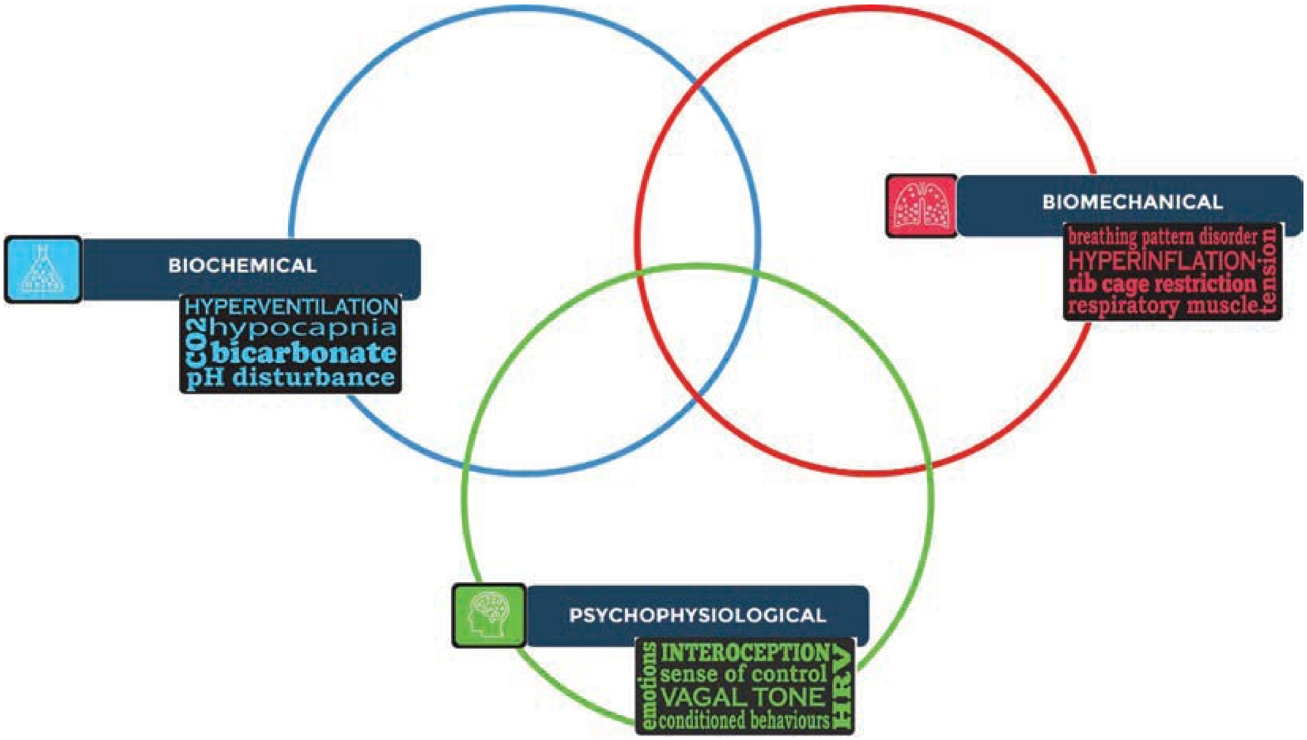


Diagram- Rosalba Courtney / FMS – Pillars of functional breathing

Biochemical

- Biomechanical refers to effects on blood gases and body chemistry (disturbances in O2, CO2 and pH).
- Hyperventilation is the most common disturbance.
- Chronic hyperventilation indicates possible abnormal breathing control and inaccurate breathing perception.

Biomechanical

- Biomechanical refers to the actions of the neuromuscular respiratory pump (NRP).
- The NRP is responsible for changes in intra-abdominal and intra-thoracic pressure
- Drives the movement of air, lymph and blood.

Psychophysiological

- Affects both Biochemical and biomechanical aspects of breathing.
- The two-way connection that exists between the brain, nervous system, mental processes, emotional states and our breathing.
- Can override and disrupt normal breathing control mechanisms.
- High scores on the Nijmegen or Self Evaluation Breathing Questionnaire (SEBQ) may indicate psychophysiological influences in breathing dysfunction
- Breathing that does not respond to actual breathing retraining, may be influenced by Psychophysiological dimensions

5.3 How should we breathe?

Breathing outside of high metabolic demand situations should always be light, quiet, effortless, soft, with a pause following the exhale and through the nose. Nasal breathing promotes diaphragmatic and rhythmic breathing and is how all humans breathed, prior to the advent of the modern world as we know it today, which has changed just about every facet of how we live. Up until around 200-300 years ago humans did not default to nasal breathing unless it was a matter of survival.

Even an athlete in good health should not be huffing and puffing like a steam train during exercise unless, they are going all out, during a high-stakes competition, or due to the environment making it impractical to maintain nasal breathing. EG a world record attempting feat that requires an all-out maximal effort or a water-based pursuit that involves airway immersion.

An individual's level of cardiovascular fitness does not necessarily reflect the quality of their breathing. Any breathing dysfunction regardless of cardiovascular ability and even that detected during rest, will result in sub-optimal breathing during higher performance activity.   That is, if your breathing is suboptimal when you are resting it will be suboptimal when you increase your performance output.

Research has linked dysfunctional breathing to a host of health conditions, including dysfunctional movement, lower back, neck and shoulder pain and it has also believed that dysfunctional breathing can adversely affect the musculoskeletal system. When breathing patterns are sub-optimal, other bodily functions, like core stabilisation, will compensate to help maintain respiration. As a result, core muscle function is significantly different in people who have dysfunctional breathing patterns and is correlated with a variety of musculoskeletal problems and an overall increased injury risk.

Note: Our system can tolerate small amounts of appropriately modulated mouth breathing. It is ok to occasionally breathe through our mouth or use the thoracic (chest) region to breath during times when it is required such as dynamic emergencies when our system is under threat or pressure to perform and we need to ramp ourselves up to take on the challenge. BUT!!!! We must be able to self-regulate this and switch back to a more parasympathetic (rest and recovery) state when the emergency has passed.

Lesson Six – Assessing breathing

6.1 Apnea Survival - Self-Assessment Breathing Questionnaire (ASSBQ)

There is no precise definition of dysfunctional breathing patterns, but it is generally accepted to include any disturbance to breathing, including hyperventilation, over-breathing, unexplained breathlessness, breathing pattern disorder or irregularity of breathing.

Many of the symptoms of dysfunctional breathing are also symptoms of anxiety (psychophysiological). A large proportion of modern humans are completely unaware, they are stuck in a self-perpetuating cycle of dysfunctional breathing and anxiety. This cycle may contribute to many performance and health impediments.

Before undertaking any breathwork or breath hold training you should assess your breathing function. A high percentage of people have dysfunctional breathing patterns most of the time. Unfortunately, most assessments are conducted in positions and states where the subject is either, made aware of their breathing, or deliberately focussed on their breathing and therefore controlling it.

To accurately assess your breathing, observations need to be made across the full spectrum of your normal daily activities. This presents a more accurate picture, of where your breathing is at and where to start correcting any dysfunction.

The Apnea Survival Self-Assessment Breathing Questionnaire (ASSBQ) has been adapted from Tess Graham's, Breathability - Breathing pattern self-assessment questionnaire, described in her book "Relief from Anxiety and Panic"

6.2 How do you breathe?

Make the following observations over the course of your normal weekly routine, several times per day (whenever you remember). If the subject answered *yes* to one or more of these questions, they may have dysfunctional breathing.

APNEA SURVIVAL BREATHING ASSESSMENT QUESTIONNAIRE

Subject name:

Date of assessment:

Time of assessment:

Person assessing:

	Questions	Y	N
1	Is your breathing heavy, laboured, audible or obvious to others?		
2	Do you feel like you can't take a full breath comfortably?		
3	Is your breathing rhythm erratic?		
4	Do you have a scratchy throat or cough frequently?		
5	Do you take random deep breaths, sigh, or yawn frequently?		
6	Do you mouth breathe at any time (including during sleep and exercise)?		
7	Do you snore?		
8	Do you wake in the morning with a dry mouth?		
9	Do you wake in the morning after sleep feeling tired?		
10	When you inhale do your chest and or shoulders rise?		
	Additional Notes:		

6.3 The Self Evaluation Breathing Questionnaire (SEBQ)

The Self Evaluation Breathing Questionnaire (SEBQ) measures breathing discomfort and contains questions about dysfunctional breathing behaviours such as, mouth breathing. It was developed by Dr. Rosalba Courtney (Courtney, Greenwood 2009) to represent the broad range of symptoms found in individuals with dysfunctional breathing. It is a reliable tool for testing and retesting, making it very useful for tracking the effectiveness of breathing retraining. The questionnaire is completed by referring to the statements and using scores below to reflect an individual's response to each.

(0) Never / not true at all

(1) Occasionally / A bit true

(2) Frequently / Mostly true

(3) Very frequently / very true

The Self Evaluation Breathing Questionnaire	0	1	2	3
I get easily breathless out of proportion to my fitness				
I notice myself breathing shallowly				
I get short of breath reading and talking				
I notice myself sighing				
I notice myself yawning				
I feel I cannot take a deep or satisfying breath				
I notice that I am breathing irregularly				
My breathing feels stuck or restricted				
My ribcage feels tight and can't expand				
I notice myself breathing quickly				
I get breathless when I am anxious				
I find myself holding my breath				
I feel breathless in association with other physical symptoms				
I have trouble coordinating my breathing when speaking				
I can't catch my breath				
I feel that the air is stuffy, as if not enough air in the room				
I get breathless even when resting				
My breath feels like it does not go in all the way				
My breath feels like it does not go out all the way				
My breathing is heavy				
I feel that I am breathing more				
My breathing requires work				
My breathing requires effort				
I breathe through my mouth during the day				
I breathe through my mouth at night while I sleep				
Sub totals				
Total score				

To Score the SEBQ add all the numbers from each question

6.4 The Nijmegen Questionnaire

The Nijmegen Questionnaire (NQ) gives a broad view of symptoms associated with dysfunctional breathing patterns. The Nijmegen Questionnaire was introduced in the 1990s as a screening tool to identify patients with hyperventilation disorders.

Do you experience any of the following?	Never 0	Rare 1	Sometimes 2	Often 3	Very Often 4
Chest Pain					
Feeling Tense					
Blurred Vision					
Dizzy Spells					
Feeling Confused					
Faster & Deeper Breathing					
Short of Breath					
Tight Feelings in Chest					
Bloated Feeling in Stomach					
Tingling Fingers					
Unable to Breathe Deeply					
Stiff Fingers or Arms					
Tight Feeling Around Mouth					
Cold Hands or Feet					
Palpitations					
Feelings of Anxiety					

Scoring the Nijmegen Questionnaire - Add all number for a total score. 20 or above indicates Dysfunctional Breathing.

6.5 The Body Oxygen Level Test (BOLT)

The relationship between breath hold time and the partial pressure of carbon dioxide (CO_2) in our body provides a useful index of respiratory chemosensitivity. When we hold our breath, CO_2 accumulates in the blood. The length of time it takes for the brain to react to the accumulation of CO_2 provides an indicator of the sensitivity of the body to CO_2. As CO_2 is the primary stimulus to breathe, breath holds are a useful method to induce an urge to breathe. The Body Oxygen Level Test (BOLT), which measures the time it takes for a person to feel their initial urge to breathe, which provides an indication of that person's sensitivity to CO_2.

As an individual's tolerance to CO_2 increases (chemosensitivity improves), the BOLT score also increases. However, the persons respiratory rate should naturally decrease and the length of natural pause following their exhalation should increase. When the BOLT score reaches forty seconds, respiratory rate is typically six to eight breath cycles per minute.

Practising a breathing cadence of six breath cycles (3-5 for resonant frequency effect) per minute provides many benefits. Such as, improved breathing efficiency. With a reduced respiratory rate, a greater volume of air per minute arrives at the alveoli (small air sacs in the lungs where gas exchange occurs). This is due to a lesser volume of air, per minute being lost to "dead space". There is also evidence to support improved heart rate variability (HRV) and performance enhancement.

Both HRV and baroreflex sensitivity are maximized when respiration is slowed to six breaths per minute or less. Baroreflex (AKA baroreceptor reflex) is a homeostatic mechanisms that assists the maintaining of blood pressure at a near constant level. Its function is to sense pressure changes, by responding to change in the tension of the arterial wall and providing a rapid negative feedback loop, during which elevated blood pressure causes the heart rate to decrease. Vice versa, decreased blood pressure decreases baroreflex activation and causes the heart rate to increase and restore blood pressure levels.
Baroreceptors respond to the pressure induced stretching of the blood vessel, in which they are found. Baroreflex-induced changes in blood pressure, are mediated by the autonomic nervous system IE. Both parasympathetic and sympathetic nerves. Baroreceptors are active during normal blood pressures, during which they relay information to the brain about increases and decreases in blood pressure. The baroreflex kicks in very quickly (fractions of a second - less than a single heart beat) and thus baroreflex adjustments are key factors in dealing with things like postural hypotension (a decrease in blood pressure on standing due to gravity). The system relies on baroreceptors located mainly in the aortic arch and carotid sinuses, to monitor variations in blood pressure.

A cadence of six breaths per minute also helps to reduce chemosensitivity to CO_2, resulting in a higher BOLT score. For persons with a strong fear of suffocation, cadence breathing may be a good option to increase CO_2 tolerance, which should reduce the persons fear response.

The synchronicity of HRV and respiration is called respiratory sinus arrhythmia

(RSA). RSA or heart rate variability in synchrony with respiration is a biological phenomenon, which may influence gas exchange, via efficient ventilation / perfusion matching. In a healthy person, the heart rate increases during inhales and decreases during exhales. Respiratory sinus arrhythmia can indicate functionality of the autonomic nervous system and may be an indicator of parasympathetic function. Greater vagus nerve traffic, slowing down the respiratory rate (increasing tidal volume) and diaphragmatic breathing will increase RSA.

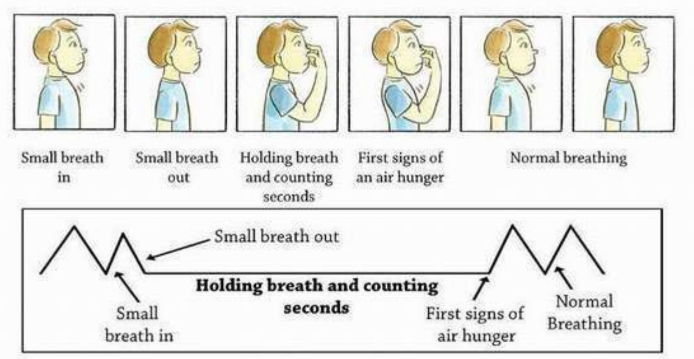
6.5.1 How to perform the BOLT.

The BOLT is a timed non-stress provoking breath-hold measurement. If you are tracking a BOLT score, conduct the test at the same time and under the same conditions, each time it is performed. For example, first thing in the morning upon waking from sleep. Perform the test as follows.

1. Breathe normally through the nose for a few minutes (ten minutes if performed later in the day).
2. Take a normal, relaxed inhale through the nose.
3. Then a normal, relaxed exhale through the nose.
4. At the end of the exhale, pinch your nostrils closed with your fingers (prevents inadvertent, sneaky inhales.
5. Count the number of seconds until you feel the first physiological impulse to breathe. EG. A swallow or diaphragmatic contraction, etc.
6. You should not feel any urge to gasp for air upon taking a breath following the breath hold.
7. If you push hard enough to create an urgent need to breathe, you've pushed too hard and this will provide a distorted BOLT score.

Note:

- The BOLT test is not a competition. It is simply a tool to help identify a person's sensitivity to CO_2.
- Holding of the breath until the first definite desire to breathe, is not influenced by training or behavioural characteristics and is an objective measurement of breathlessness.
- Voluntary breath-holding duration is thought to provide an indirect index of sensitivity to CO_2.



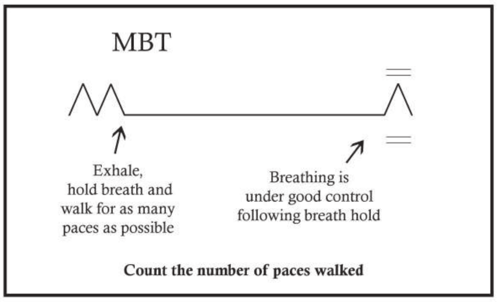
6.6 The Maximum Breathlessness Test (MBT)

Due to CO_2 being the primary stimulus to breathe, restricting its expiration during exercise is a yet another way to induce the urge to breathe. The Maximum Breathlessness Test (MBT) measures the time it takes for the urge to breathe to occur during exercise. The MBT is basically a moving version of the BOLT and provides an additional indicator of respiratory chemosensitivity, that can be correlated with a BOLT score, creating a more accurate picture of a person's chemosensitivity.

6.6.1 How to perform the MBT

The MBT is a timed non-stress provoking breath-hold measurement. If you are tracking MBT scores, conduct the test at the same time and under the same conditions each time it is performed. Example, first thing in the morning upon waking from sleep. Perform the test as follows.

1. Breathe normally through the nose for a few minutes (ten minutes if performed later in the day).
2. Take a normal, relaxed inhale through the nose.
3. Then a normal, relaxed exhale through the nose.
4. At the end of the exhale, pinch your nostrils closed with your fingers (prevents inadvertent, sneaky inhales).
5. Walk at a normal relaxed walking pace, counting the number of steps you can take until you feel the first physiological impulse to breathe. EG. A swallow or diaphragmatic contraction, etc (left and right is two steps).
6. You should not feel any urge to gasp for air upon taking a breath following the breath hold.
7. If you push hard enough to create an urgent need to breathe, you've pushed too hard and this will provide a distorted score.
8. Your score is the maximum number of paces you can held your breath for.
9. The goal is 80 to 100 paces.
10. Fewer than 60 paces indicates room for improvement.



6.7 Chart showing correlation between BOLT and MBT scores.

	BOLT	MBT
Dysfunctional Breathing	10	20-40
	20	40-60
	25	60
Functional Breathing	30	60-80
	40	80-100

"To increase your BOLT score, you must lower carbon dioxide losses, increase your tolerance for carbon dioxide, and practice breathing exercises that simulate high-altitude situations where less oxygen is naturally available." Patrick McKWEON (Oxygen Advantage founder).

Use the same methods to improve the MBT score.

Note: Both BOLT and MBT information was derived from Patrick McKWEON and the Oxygen Advantage – Advanced Instructor training manual.

6.8 Functional Movement Systems (FMS) - Dysfunctional Breathing Questionnaire / Assessment.

The FMS breathing screen was developed to help identify people who do / do not have a breathing dysfunction. It has been found that breath hold time (FRC and TLC) plus 4 specific questions, developed by the FMS research team, provides an accurate way of elimination dysfunctional breathing as a symptom. If a person passes the screen there is an 89% chance, they do not have a breathing dysfunction that warrants intervention. *(Kiesel, Rhodes, Mueller, Waninger, Butler, 2016)*.

Interpreting the FMS Breathing Screen

- *Green*: Breathing is optimal and individual likely moves very well.
- *Yellow*: Some deficits, proceed with caution by monitoring and adding breathing retraining to activity and add some breathing retraining.
- *Red:* Stop. Address breathing dysfunction, prioritise treatment of breathing, and do not load this group with resistance.

FMS Breathing questionnaire

Red: Score of 2 or 3

Yellow: Score of 1

Green: Score of 0.

The score is determined by adding all scores for question responses and dividing by the number of questions (4).

FMS Breathing questionnaire answers

Subject Name:

Date of assessment:

Assessor name:

	Question	Score 0-3
1	**Do you feel tense?** (0) never/not true at all (1) occasionally/a bit true (2) frequently-mostly true (3) very frequently/very true	
2	**Do you feel a cold sensation in your hands or feet?** (0) never/not true at all (1) occasionally/a bit true (2) frequently-mostly true (3) very frequently/very true	
3	**Do you notice yourself yawning?** (0) never/not true at all (1) occasionally/a bit true (2) frequently-mostly true (3) very frequently/very true	
4	**Do you notice breathing through your mouth at night?** (0) never/not true at all (1) occasionally/a bit true (2) frequently-mostly true (3) very frequently/very true	
	Total score = (1+2+3+4) ÷ 4	

Additional notes:

6.9 Breath holds used during the FMS breathing screen.

6.9.1 Functional Residual Capacity (FRC) breath hold (modified BOLT)

Red: < 25 Seconds Yellow: 26 - 35 Seconds Green: > 35 Seconds

Instructions:

1. Lay supine on the floor with knees bent and feet flat on the floor.
2. Breathe in, breathe out through the nose at a natural breathing cadence.
3. At the end of the exhale, hold the breath and block the nose.
4. Hold the breath until a clear desire to breathe or involuntary muscle activity from the diaphragm, swallowing or other breathing muscles is experienced.
5. Time starts as soon as the person begins the breath hold and stops when nose is released or the first sign of muscle activity is observed.

Note:

- < 25 seconds is an indicator of dysfunctional breathing.
- For best results perform the FRC test under the same conditions and same time each occasion it is performed.

6.9.2 Total Lung Capacity (TLC)

Red: < 35 Seconds Yellow: 36 - 60 Seconds Green: > 60 Seconds

TLC refers to the total volume of air in the lungs at maximum inhale. This test is performed to break point (until the breath can no longer be physically held).

1. Lay supine on the floor with knees bent and feet flat on the floor.
2. Breathe in, breathe out naturally.
3. Take a maximum breath in through the nose and hold with nose pinched.
4. Hold the breath to break point (Muscle activity is permitted in this test so hold as long as physically possible).
5. Time starts as soon as the person begins the breath hold and stops when nose is released and the subject breathes.

Note:

- < 35 seconds is an indicator of dysfunctional breathing.
- For best results perform the TLC test under the same conditions and same time each occasion it is performed.

6.11 The High Low self-test (biomechanics)

The High Low self-test is performed in the sitting position. The subject places one hand on their sternum and one hand on their upper abdomen, to detect whether thoracic or abdominal motion is dominant during their breathing. They will also check for paradoxical breathing by observing their abdomen to see if it moves in a direction opposite to the thorax during breathing.   That is, during inhale the abdomen moves toward the spine and during exhale if moves outward. Use at least five (5) breath cycles to perform the test.

6.12 Crocodile breathing

The position:

1. Take up a laying prone position with your face down, stomach on the floor and forehead on your hands, both palms down, one covering the other.
2. Relax the chest and arms and flatten and relax your entire body as best you can, with neck relaxed and comfortable.
3. Weight should be on your chest more so than on your chest the edge of your ribs.
4. Breathe in through the nose and feel the air move down past the chest into the abdomen (stomach area).
5. You should feel the abdomen expanding and pushing against the surface you are laying on and laterally, this should occur without you having to force the stomach out.

The procedure:

1. Take a natural nasal inhale and exhale.
2. Nasal inhale should be a low, slow and around 3 seconds in duration.
3. Pause briefly.
4. Fully exhale through the nose.
5. Nasal exhale should be slow and full 4-6 seconds
6. Pause again (longer than the pause following the inhale. 2-3 seconds)
7. Repeat the next breath cycle.
8. The abdomen should expand in a 360-degree circumference like you're filling a cylinder.

Crocodile breathing diagram from FMS Functional Breathing Certification

Lesson Seven - The Apnea Survival - Full Lung Breathing (FLB) drill

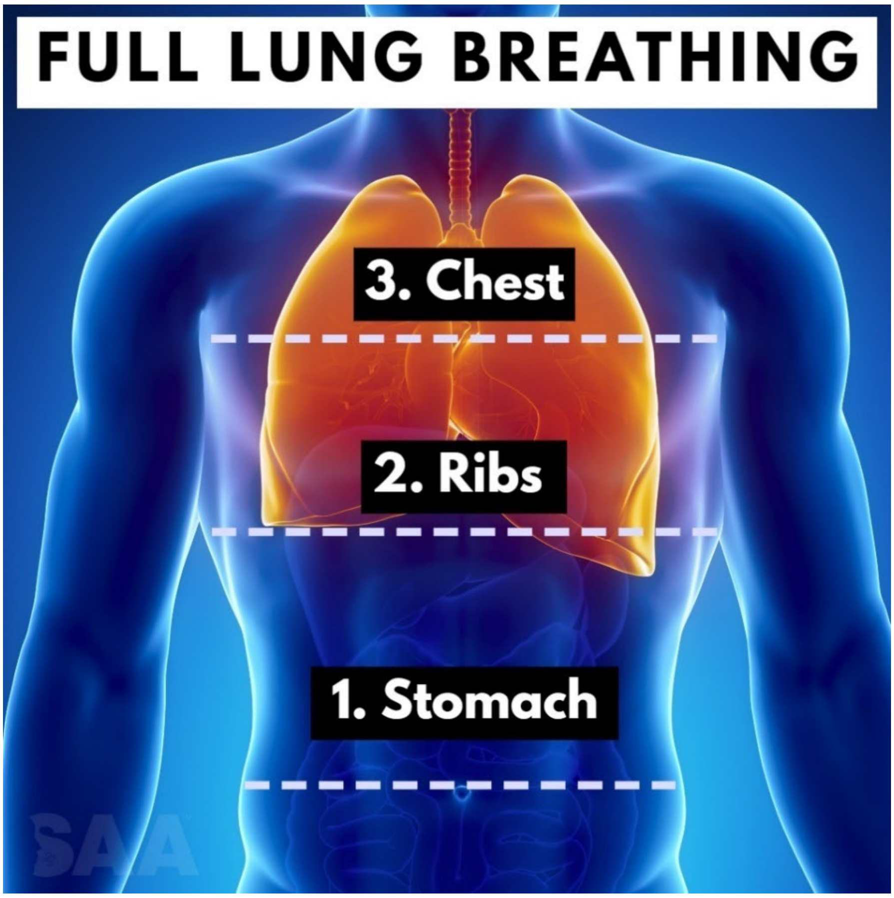
There are many benefits of initiating an inhale by breathing into the lower abdomen first. Such as:

- Activates parasympathetic toning
- Reduces effects of the stress hormone cortisol.
- Lowers heart rate.
- Lowers blood pressure.
- Improves core muscle stability
- Slows breathing rate which conserves energy.
- Reduces over all stress.

When used for relaxation the aim of FLB is to eventually, soften and quieten the breath to a point where air flow and body movement is virtually undetectable. If practising the relaxation version of this drill, it is possible you may become so relaxed you will fall asleep on the floor! It's an epic drill for down regulating (unwinding) prior to bed.

The key to entering a deep state of relaxation using the FLB, is to reduce your breath cycles (inhale + exhale) to 3-5 cycles per minute. This creates a "resonance frequency effect" that places the body and mind into a state of deep relaxation and resets and balances all systems in the body.

The Full Lung Breathing exercise can be used as both an assessment and relaxation tool depending on how it is performed.



7.1 Performing the FLB

1. Lay flat on your back on the floor and get comfortable (place a pillow or cushion under the back of your knees, etc if required to get comfortable).
2. Breathe only through the nose using your natural resting breath cadence.
3. Place your hands lightly on your stomach and breathe only into your stomach (lower lung lobes). As you inhale, feel your stomach and circumference of your abdomen expand. Think of your torso as a 360° cylinder. All sides need to expand when you inhale and then contract during the exhale.
4. Inhale for a count of 3-5 and exhale for a count of 9-15 or whatever you're comfortable with. Note: when exhaling you are releasing the same amount of air as you inhaled, but slower and with more control. If you're not able to perform 5/15 try 2/6 or 3/9.

Wherever you fall, try as best you can to maintain the ratio of 1:3 for Inhale : Exhale. If it is to challenging try a ratio of 1:2 to start with.

5. Continue for 2 minutes.
6. After 2 minutes slide your hands up either side of your body to your lower ribs so the thumbs run vertically up the body and the fingers are relaxed and point inward toward the centre of the torso and breath only into your rib region.
7. As you inhale allow your ribs to open and expand and again ensure the 360° circumference of your torso EG the middle back is also expanding. Your middle back should press gently into the floor as you inhale.
8. Exhale. Let everything relax, your ribs collapse and back pull away from the floor. If you're having trouble moving your ribs use your hands to lightly press them in when you exhale and release the pressure allowing them to expand when you inhale. This will provide sensory feedback that will help getting any sticky ribs moving again.
9. After 2 minutes slide your hands up to your chest and breath only into your chest. As you inhale allow your chest to expand and ensure the circumference of your torso EG upper back and lats is also expanding. Your upper back should press gently into the floor and your upper ribs should fan out as you inhale.
10. Continue for 2 minutes.
11. After 2 minutes. Still breathing through the nose only. Combine all 3 stomach, ribs and chest, into one single movement while inhaling and exhaling.
12. Once you've got the hang of this focus on the timing of your breath. Inhaling for 4-5 counts, slight pause then exhaling gently and controlled for 10-15 counts followed by another pause at the bottom of the exhale then inhale again.
13. Soften and quieten your breathing. Try to make it so soft and gentle, it is undetectable. Remove the emphasis on the mechanics and inflation of the chest.
14. Continue for 4 minutes.

Total time 10 minutes.

Parts 11-12 can be used on their own for 5 – 10 minutes, as a powerful relaxation tool. Particularly when breath rate is reduced to 3-5 cycles per minute. As breathing is lowered, slowed and lengthened, chest movement will naturally reduce and eventually the body movements accentuated during the development of FLB exaggerated learning phase, will become more subtle.

7.2 Using the FLB as an assessment tool

1. Sit or stand comfortably.
2. Breathe at a natural pace, in and out through the nose as you would during normal rest.
3. Place your hands at your sides and feel your lower two ribs.
4. Breathe in and note how your stomach is moving.
5. Breathe out and note how your stomach is moving.
6. Breathe in and note how your ribs are moving
7. Breathe out and note how your ribs are moving
8. Breathe in and note how your chest is moving
9. Breathe out and note how your chest is moving

10. Listen to your breathing.   How audible is it?
11. Is your breathing deep or shallow?

Now compare your assessment with how good functioning breathing mechanics should look and feel according to the Oxygen Advantage Instructor Manual by Patrick McKweon, author of the Oxygen Advantage, The Breathing Cure and Automic focus.

- As you breathe in, your belly button area and the circumference around your abdomen should rise and expand outward.
- As you breathe out your belly button area and its circumference should flatten inward
- As you breathe in your ribs should move outwards.
- As you breathe out, feel your ribs moving inward.
- Your breathing should be light, slow and low
- Your breath rate should be 3-6 cycles per minute
- Reducing the number of breaths allows each breath to be deeper (longer and lower).
- Take fuller breaths, but fewer of them.
- Ideally, during inhalation, as the diaphragm moves downward and the intercostal muscles move outward, this generates outward movement to the front (abdominal), sides and back and intra-abdominal pressure to push the ribs outward.

The objective is to be able to maintain the ability to breathe light, slow and deep (long and low) during at rest and moderate exercise like walking.

Lesson Eight - Assessing the three pillars

8.1 Biochemistry

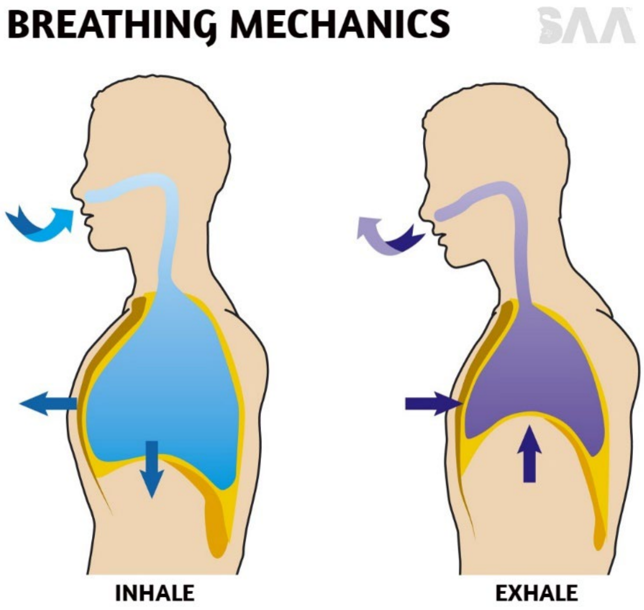
Definition – Biochemistry refers to "the chemical processes within and relating to our living bodies". (Merriam-webster dictionary)

When we hold our breath O2 is prevented from entering the lungs and excess CO2 is prevented from being exhaled. As the breath hold continues, CO2 accumulates in the lungs and blood, while O2 levels decrease slightly. Due to CO2 being the primary stimulus for breathing, the length of a breath hold is primarily influenced by how much CO2 a person can tolerate (ventilatory response to CO2). A strong ventilatory response means the threshold will be reached sooner, resulting in a lower breath hold time. However, a good tolerance (reduced ventilatory response) results in longer breath hold times.

A comfortable breath hold duration can serve as an indicator of a person's breathing volume / chemosensitivity. Although several other variables may impact a breath hold, under controlled conditions the BOLT, MBT, FRC and TLC all provide a reliable measure of an individual’s chemosensitivity. The lower the BOLT, MBT, FRC and TLC scores, the greater the breathing volume, and the greater the breathing volume, the more breathlessness an individual will experience during exercise.

8.2 Biomechanics

Definition – Biomechanics refers to, “the structure, function and motion of the mechanical aspects of our bodies and the effects that forces have on the motion of that body. (Merriam-webster dictionary)



The diaphragm is a thin muscle that sits at the base of the chest and separates it from the abdomen. When you inhale your diaphragm contracts and pulls downward increasing the space (volume) in and around your lungs allowing them to expand. The muscles between your ribs (intercostals) also play a significant role to enlarge the chest cavity. They work to pull your rib cage upward and outward when you inhale, again increasing the space in which the lungs can expand.

As the diaphragm contracts and the thoracic cavity space increases, the pressure inside the lungs is reduced to the point where it is less than atmospheric pressure outside of your body. This creates vacuum effect which draws air into the lungs (area of lower pressure) via the airways from outside the body (area of higher pressure).

When you exhale your diaphragm relaxes upward reducing the space in and around the lungs decreasing the lung volume. The intercostals also assist by contracting the rib cage. This process increases the internal pressure of the lungs to a point where it is greater than the air pressure outside the body and causes air to move out of the lungs via the mouth or nose to the surrounding atmosphere of less pressure.

Assessment of the efficiency of breathing mechanics can be performed using the FLB, High Low Self-Test and Crocodile breathing, to conduct both visual and / or tactile observations of the components of the movement of the muscular skeletal system recruited to perform the ventilation.

8.2.1 Indicators of biomechanical dysfunction

- Breathing through the mouth
- Upper chest movement
- Audible breathing during rest
- Frequent sighing
- Frequent yawning
- Paradoxical breathing (deflation the lungs or of a portion of a lung during inspiration and the inflation of the lung during expiration)
- Obvious breathing movement during rest

Stress breathing patterns appear very similar to dysfunctional breathing. When we are stressed our breathing:

- Increases in speed
- Becomes more irregular
- Has increased sighing (physiological sighing)
- Is more audible
- Has more noticeable movement
- Is more through the mouth
- Moves to the upper chest and shoulders

Having good breathing mechanics:

- Improves blood circulation
- Opens upper (nose) and lower airways (lungs)
- Reduces breathlessness
- Reduces bronchoconstriction (asthma)
- Conserves energy
- Improves vagal toning
- Maintains autonomic balance
- Increases HRV, respiratory sinus arrhythmia (RSA) and baroreceptor function
- Improves sleep, focus, concentration and feelings of calm
- Improves posture, stabilisation, movement

8.2.2 Intra-abdominal pressure and breathing light

The diaphragm is also important for postural control, and functions through the generation of intra-abdominal pressure (IAP). During inhalation, the diaphragm moves downward and IAP is generated, providing a stabilising effect and support for the spine and pelvis. For example, prior to a heavy lift, weightlifters breathe in and hold their breath to generate higher IAP, which increases tension and torque, supporting the spine.

Good breathing function increases our ability to generate IAP and spinal support, which ensures postural integrity during movement. The lateral expansion of the lower rib cage (imagine your torso is a cylinder expanding around its entire 360° circumference) that should accompany good breathing function, will only occur if there is sufficient IAP acting through the zone of apposition (ZOA) to push the ribs out. The ZOA is the area of attachment (apposition) between the diaphragm and the ribcage which plays a significant role in good diaphragmatic function.

The exaggerated movements of the FLB can aid in developing good mechanical function and control of the ZOA and diaphragm. However, once this is established, the objective is to soften and quieten our breathing as much as possible, remove the exaggeration keeping the breath cycles low and slow, whilst maintaining the ability to create relative IAP.

8.3 Psychophysiology

Definition – Psychophysiology refers to "physiology that deals with the interrelation of mental and physical phenomena." (Merriam-webster dictionary)

Psychophysiology affects both biochemical and biomechanical aspects of breathing and refers to the two-way connection that exists between the brain, nervous system, mental processes and emotional states and our breathing.

The assessment of psychophysiological components of breathing can be performed using the Nijmegen Questionnaire, SEBQ and ASSQ to collect information regarding what psychological drivers EG stress, may be influencing other aspects of breathing.

Lesson Nine – The urge to breathe

9.1 What drives the urge to breathe?

Being aware of and recognising the physiological and psychological changes that occur within us as we navigate a breath hold helps us to understand what the urge to breathe (feeling that you need to take a breath) is and what is driving it. From a young age most people associate the feeling of having to take a breath (the urge to breathe) with low O2 levels. Because of this thinking, when we initially experience an urge to breathe, we associated it with suffocation and the perception that we must take a breath or we will die because we are running out of O2.

However, the urge to breathe is not driven by low O2 levels. Any urgency associated with it, is purely a perception that we have trained over the course of our lives. Based on our misgiven association between the feeling of needing to take a breath and low O_2. Once we understand the urge to breathe is not an indicator of low O_2 and we are not about to suffocate, we can begin to relax and challenge the duration of our breath holds.

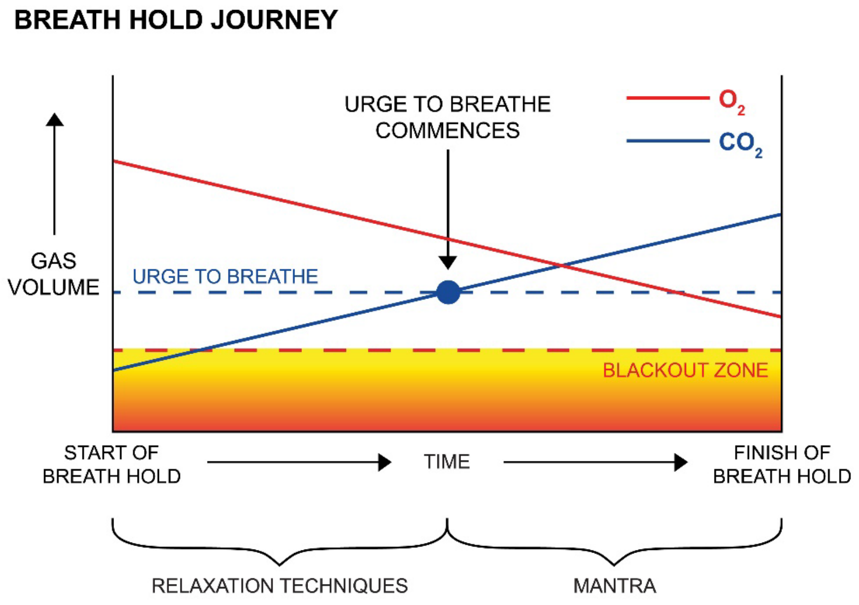
Remember CO_2 is a product of aerobic respiration and is transported from the cells and tissues to the lungs for exhaling during normal breathing. When we hold our breath, we prevent the exhalation of CO_2 from our body. Once the levels of CO_2 in our body reach the point where we would normally take a breath, our brain and body go into action sending irritating reminders throughout our various systems, to encourage us to breathe. These reminders arrive in the form of swallowing impulses, diaphragmatic contractions, other muscle contractions EG chest and throat and can get gradually more aggressive and violent.

This process relies on our body's sensitivity to the rising levels of CO_2. CO_2 is carefully monitored by the body via its chemoreceptors, as its presence impacts the function of all our systems. Such as, blood pH, the acid / alkaline balances and organ function. Every individual has a unique sensitivity to CO_2, based on the way they breath (chemosensitivity). This sensitivity is calibrated by a central governing set point in the brain, relative to our daily breathing. This level of sensitivity drives the triggers that stimulate our breathing response (when our body decides to inhale and exhale).

Note: The body will react to low levels of O_2 but not until it is critically low (20-30%), in which case it will generally immobilise us (black out). Knowing the urge to breathe is not driven by low O_2, enables us to push through its initial discomfort and significantly lengthen our breath hold. Having a long breath hold is about managing the stress created by CO_2 and the urge to breathe.

A simple drill to demonstrate this is to use an oxypulsemeter during your breath holds to observe your O_2 levels, whilst experiencing strong urges to breathe. Most people are extremely surprised, to see that after a couple of minutes of holding their breath, their peripheral O_2 saturation levels remain close to normal, in the mid to low 90%. Add to this, the knowledge that the average person can safely push their O_2 saturation to below 70% (depending on training and personal nuances), relaxing during the stressful end of a breath hold should be less of a challenge.

As per the Breath Hold Journey diagram below, when a breath hold is performed following normal breathing, the urge to breathe occurs, on the average person around 50% of the way through their breath hold (general only) and is well clear of any cerebral black out risk (black out resulting from the brain being deprived of O_2).



9.2 Practical - "Breath Hold Journey" drill.

Equipment required for this drill:

1 x Oxypulsemeter

1 x nose clip (optional)

The drill consists of two breath holds. Do not worry about how to breathe up, prepare for, or recover from breath holds just yet. It does not matter how long your breath hold goes for with this drill. What participants need to focus on, are the sensations they experience during the breath hold and what the thing was that prompted them to breath. IE how they felt physically and mentally and what was it that made them decide to take a breath.

The average person at sea level when breathing, at rest, in a normal relaxed manner, will have an O2 saturation of around 97-99% (as measured by the Oxypulsemeter). Check this before you start this drill. If your resting O2 saturation is 95% or below and remains there, you should consult a medical professional.

- Be mindful when using an oxypulsemeter that there may be a delay in the reading of up to 20 seconds (with most oxypulsemeters). So, you may find once you start breathing after the breath holds the oxypulsemeter will indicate your O2 saturation is still dropping. Disregard this as within 30-45 seconds with normal breathing your O2 saturation will return to its full or near full capacity.

Breath hold # 1.

6. Relax and when you are ready take a last breath in and hold it for as long as you can.
7. During the breath hold be sure to block your nose, by pinching it with your thumb and forefinger, or wearing a nose clip. This ensures there is no sneaky breathing (unintentional breathing that can occur via your nose as pressure builds up in your

airways).
8. Continue the breath hold until you need to breathe.
9. Rest with natural nasal breathing two minutes
10. Think about what triggered your ceasing of the breath hold and taking of a breath.

After you have recommenced breathing following the breath holds, take a couple of minutes to rest and relax. During this time think about what drove your decision to resume breathing and what sensations and changes in your mind and body you experienced as the breath hold progressed?

Breath hold # 2.

Following 2-5 minutes rest after breath hold #1, attach the oxypulsemeter to your finger and activate its functions so you can observe your O2 saturation.

Perform a second breath hold, as per breath hold #1, but this time use the oxypulsemeter to keep track of your O2 saturation. When you feel like you need to breathe, observe where your O2 saturation is at. Remember it does not get critical until you are at 20-30% and it is perfectly safe for most healthy people to drop it into the 70 or 60%s. Now push yourself a little further beyond what you felt in the first breath hold.

5. Relax and when you are ready take a last breath in and hold it for as long as you can.
6. During the breath hold be sure to block your nose by pinching it with your fingers or wearing a nose clip. Do this by pinching your nostrils closed with your thumb and forefinger. This ensures there is no sneaky breathing (unintentional breathing that can occur via your nose as pressure builds up in your airways). This helps to intensify the experience and enables you to push a little harder and emphasise the point of the demonstration.
7. When you feel the urges to breathe, push a bit harder and go beyond the point at which you chose to breathe in breath hold #1.
8. Continue the breath hold until you need to breathe whilst observing your O2 levels.

What was your O2 saturation when you needed to breathe?

Unless you are a trained breath holder it is unlikely your O2 saturation dropped much below 90% before you decided to breathe. Some people on their first few breath hold journeys have very little to no change in O2 saturation at all, due to them succumbing to the urge to breathe prior to any substantial use of O2.

A well-trained breath holder with a five-minute static breath hold may be around 85% sPO2 saturation at the 3.30 minute mark. So, this provides a reasonable indication of:
1. How long a breath hold you may have, and
2. How the urge to breathe is not driven by low O2.

This is a powerful exercise and most first-time breath holders are surprised by how little O2 they use when holding their breath. Reality is, during normal breathing in a relaxed state the body uses only around 4% of inhaled O_2 and the rest is expelled during exhalation.

9.3 Your response to elevated CO_2

CO_2 is an irritant gas produced as a by-product of metabolism (aerobic respiration) and is also a regulator of many bodily functions, including breathing dynamics. For this reason, the brain keeps a close eye on CO_2 levels in the body.

Some of things CO_2 does include:

- Stimulate Breathing
- Adjust blood chemistry (lowers pH and increases acidity)
- Dilates capillaries
- Drives the Bohr Effect

High levels of CO_2 (above the central governing set point) relative to an individual's "normal" breathing, will trigger a much harder, more forceful breathing pattern as the body attempts to regcalibrate gas levels, by dumping out what it perceives as excess CO_2.

Remember. The brain also measures O_2 levels in your body but does not act unless it is critically low (20-30%).

9.4 Suffocation Alarm Response

The suffocation alarm response prompts the need to breathe when we are holding our breath (or when you are out of breath). Creating the sensation that we will suffocate if we do not take a breath. The purpose of the alarm is to stimulate you to breathe.

The "suffocation alarm response" is associated with the urge to breathe and is driven by rising levels of CO_2.

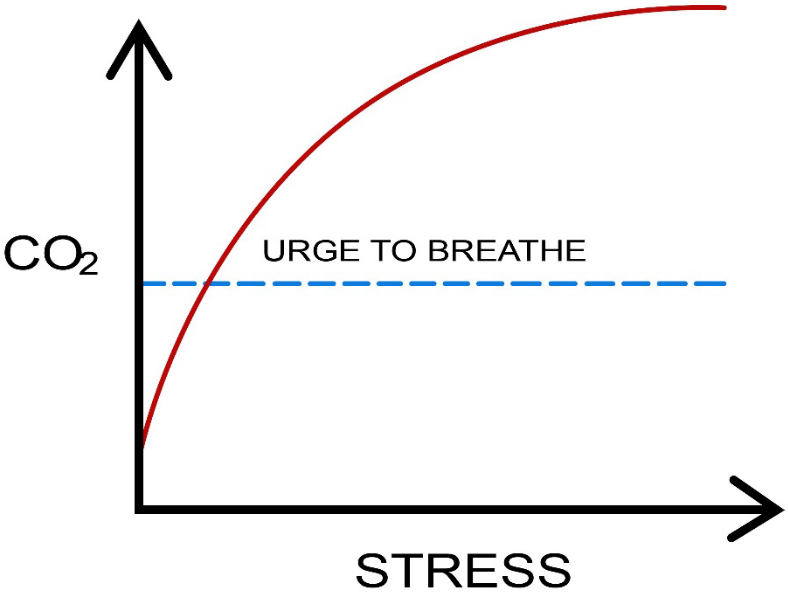
- You have a CO_2 tolerance set point based for your everyday breathing patterns
- The way you breathe impacts your body's tolerance to CO_2
- Increased CO_2 causes the body stress and triggers a sympathetic (fight or flight) response and stimulating a feeling and fear of suffocation.
- Increased CO_2 triggers an anxiety / panic response via the amygdala. The amygdala is in the limbic system and plays a key role in how we assess and respond to environmental threats and challenges, by evaluating emotional importance of sensory information.
- The amygdala's main job is to regulate emotions, such as fear and aggression. The amygdala is also involved with linking emotions to our memories, reward processing, and decision-making.
- The suffocation alarm response, is a 'false' alarm that is supported by learned behaviours, associated with our relationship with CO_2 and our perception of what

the urge to breathe indicates. EG "*AAAAAAGHHHHHHHHH I'm running out of air and will die if I don't take a breath soon!!!!!!*"

9.5 CO2 and stress

CO2 is often referred to as the stress molecule, as it is frequently associated with our ability to manage stress. This is due to CO2 being an irritant gas that stimulates our urge to breathe by creating psychophysiological stress.

As CO2 increases our stress increases and vice versa. This is represented in the diagram below. The greater tolerance to CO2 we have, the greater our tolerance to stress. Our tolerance to both CO2 and stress can be improved with progressive exposure (familiarity created by training and practise).



Lesson ten – Breath Hold Journeys

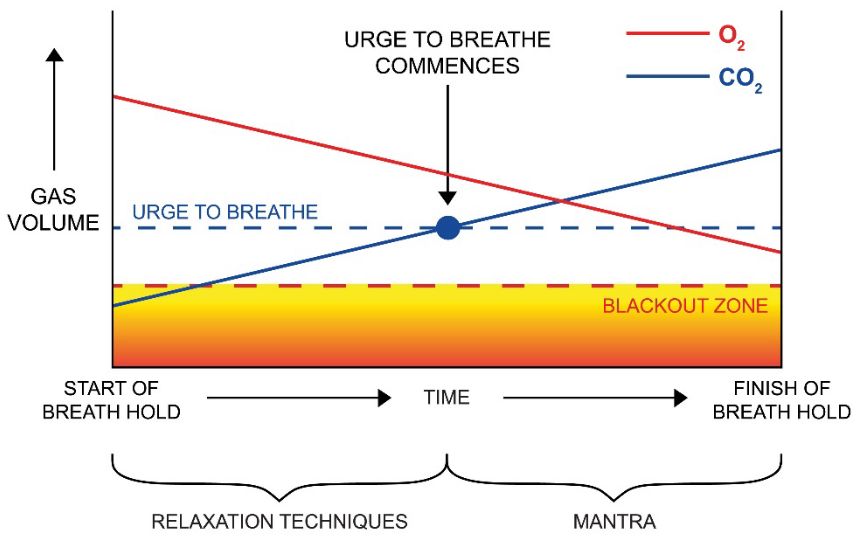
10.1 The Breath Hold Journey

The Breath Hold Journey is the combination of psychological and physiological sensations we experience whilst navigating our way through a breath hold. Breath holding is as much a mental exercise as it is physical, so it helps to understand the processes going on in our body and mind. This subsequently allows us to use that knowledge to navigate our way through the breath hold challenge.

There is a saying amongst freedivers, "The breath hold does not begin until the urge to breath kicks in". Meaning that the real challenge of holding your breath does not begin until all those little breathing reminders start to cause us stress. The better you can tolerate higher levels of CO2 and manage your body's reactions when it's trying to get you to breathe. The further you can push through the back end of the breath hold and the longer your breath hold duration will be.

An important component of the *Breath hold Journey* is to understand, be aware of and be in control of the sensations we associate with needing to breathe. Plus, learning how to occupy our mind to distract ourselves away from the concept of time and those sensations, including those sent to prompt us to breathe. The *Breath Hold Journey* diagram below shows how, O2 and CO2 volume change during a breath hold, following normal relaxed breathing. You can see the urge to breathe provides a safety mechanism by prompting us to take a breath, well before we are near any risk of unconsciousness.

BREATH HOLD JOURNEY



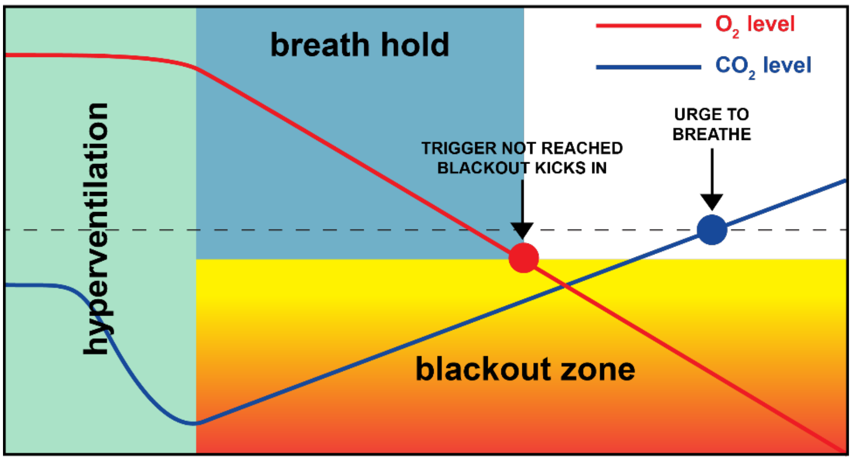
Points to remember:

- Rising CO2 drives our urge to breathe and is the driving force behind the stress we experience during challenging breath holds.
- During a breath hold that follows normal breathing the urge to breathe kicks in way before any risk of blacking out (at around 50% of the average healthy persons total breath hold duration).
- The urge to breath can be our best friend, as it provides an indicator of our breath holding limits.
- The urge to breathe helps prevent cerebral hypoxia (black out).

10.2 Hyperventilation

Hyperventilation is "Breathing in excess of our metabolic demands" That is, an excessive rate and depth of breathing, that results in an abnormal loss of CO2 from the blood. The below diagram shows the O2 and CO2 gas relationship during a breath hold following hyperventilation. This practise can result in a dumping of CO2, thereby reducing levels of the gas to a point where it would significantly delay the urge to breathe and increase the risk of black out.

HYPERVENTILATION



Delaying the urge to breathe during longer breath holds can result in unintended black out. This is due to O2 levels reaching critical limits before CO2 levels rise enough to trigger the urge to breathe and stimulate the breath holder to take a breath.

Rapidly lowering CO2 levels in the body delays our urge to breathe. Creating a scenario where O2 levels can drop to below critical levels prior to the breath holder feeling any desire to take a breath. This significantly increases the risk of black out and death. Particularly when the breath holder is underwater.

Points to remember:

- Hyperventilation flushes CO2 out of the body and excessive hyperventilation disturbs the delicate gas balance within the body, by lowering normal CO2 levels and delaying air hunger (urge to breathe).
- When the urge to breathe is delayed we are at greater risk of black out.
- Black out can result from O2 levels reaching critical limits before CO2 levels rise enough to trigger an urge to breathe, that is strong enough to stimulate the recommencement of breathing.

10.3 The hypoxic breath hold Journey

Hypoxemia is below-normal levels of O2 in our blood, specifically in the arteries. Hypoxemia is related to breathing or circulation and may result in various symptoms, such as shortness of breath, dizziness and confusion.

Normal arterial oxygen is approximately 75 to 100 mm of mercury (mm Hg – a measurement of pressure). Values under 60 mm Hg usually indicate the need for supplemental oxygen. Normal pulse oximeter readings should range from 95 to 100 percent. Values under 90 percent are considered low and hypoxic.

Hypoxia is a physiological state, during which, part or all the body is deprived of O2 at a tissue level. It is an O2 starvation event that can have multiple adverse signs and symptoms. However, if hypoxia occurs in a controlled environment and intermittently it can alleviate various pathological conditions and create physiological adaptions that improve health and performance.

In biology and medical science, hypoxia is referred to as a condition of the body which results in tissues being starved of O2. Four types of hypoxia are referred to in medicine, however, for our purposes we will focus on the one that is influenced by breathing and breath holding. Referred to as hypoxemia. Hypoxemia is when O2 pressure in the blood circulating the body is too low to saturate the haemoglobin.

Intermittent hypoxia is known stimulate several adaptive responses. These adaptive responses include preparing the body to better tolerate future hypoxic events. Evidence shows that the nervous system increases the production of growth factors during hypoxia to counter any injurious effects it may cause.

When you hold your breath on an exhale (even a passive one), you significantly reduce the reserve of O2 in your lungs, which means you can no longer maintain O2 levels as a breath hold progresses. As O2 levels gradually decline during a breath hold following an exhale, you do not have sufficient reserves of O2 in the lungs to replenish the O2 being used by the tissues. Eventually peripheral O2 saturation can decline way before CO2 rises enough to stimulate breathing. This allows the breath holder to push their bodies O2 levels much lower before CO2 rises enough to force a breath hold break point.

For this reason, during exhale breath holds it is possible to lower SaPO2 levels much lower than when holding your breath on an inhale. It is not uncommon for a breath holder to reduce their peripheral O2 saturation levels to as low as 30% and remain conscious or even to the point of black out. O2 is replenished in 20-30 seconds following the break of the breath hold and commencement of normal relaxed nasal breathing. For this reason, intermittent hypoxia training is an effective and efficient way to simulate the effects of low O2 environments like altitude. During an exhale breath hold you can expect to experience a variety of sensations associated with hypoxia that are not experienced during inhale breath holds. Including,

- Confusion
- Dizziness
- Cyanosis of lips, tongue, and face
- Tingling and numbing sensation in extremities
- Gasping for air or hyperventilation
- Dilation of the pupils / saucepan eyes
- A much stronger urgency to breathe
- Loss of motor control

Lesson 11 – Focussing during stressful situations (breath holds and cold immersion).

11.1 Relaxation techniques

The relaxation phase of a breath hold, or any stress causing event, precedes any strong urge to breathe, or period of intense discomfort and is ideally maintained for as long as possible.

Relaxation techniques include:

- Closing the eyes (reduces sensory input and promotes relaxation)
- Body scanning (isolating, visualising and relaxing each body part).
- Visualisation (creating a picture or movie in your mind using your imagination. EG. A work project, physical activity, or passion)
- Remote viewing (projecting your mind to receive information from elsewhere without having to leave your body).
- Out of body experience (perceiving the world from a location outside of our physical body).
- Audio imagination EG Playing verses, poetry, singing or playing music in your head
- "Being the water" (imagine yourself melting into the water and becoming at one with it or becoming the water itself)
- Listen to the sounds around you and visualise what is making the noise you are hearing
- Listen to or feel your heart / pulse beating.
- Deconcentration of attention. Opposite to concentration. The dismantling of stimulus in the field of perception EG not focusing on any particular point in a field of vision or sound. Allow all stimulus to flood your sensors.
- Take off your watch! (Avoid any reference to time, as this can spark a reaction that may result in you wanting to breathe)
- Flow. With whatever is going on, in and around you. Go with the swallows and contractions as they come. As CO_2 starts to build in your system it will generate muscular contractions, in an attempt to make you breathe. Try not to fight these. Rather focus on their rhythm and flow with it.

Try out a few different methods of relaxation to find the one that best works for you then stick with that one.

11.2 Mantras

Once the CO_2 begins to accumulate in your system to higher-than-normal levels, it will begin irritating you in attempt to force breathing. Things will start to get quite uncomfortable. Likewise, if you're battling with the stress of prolonged cold-water immersion, or any other stress causing event and the intensity is reaching a point where relaxation and stilling the mind has become super challenging, it is time to change up your distraction / focus technique to a mantra.

Once the stress of the challenge increases to a point where it is difficult to relax, try to relax into it more. Leaning in, is the term often associated with accepting the increase in stress and deepening your attempt at relaxing into it. Battling or fighting with yourself and your stress generally increases it. The key is to remain as relaxed and least stressed as possible. However, eventually the pressure and will become increasingly severe and it will be virtually impossible to remain in a Zen type state.

When this occurs, we need to switch from relaxation techniques to something more powerful like a *mantra*. Traditionally a *mantra* is a sacred word, sound or phrase repeatedly recited to harness and focus the power of the mind. The word itself is derived from two Sanskrit roots: 'manas' meaning 'mind' and 'tra' meaning 'tool'. Mantras are "mind tools," used to direct the focus of the mind and change our perceptions of existing realities to influence our behaviour and outcomes.

During the high stress end of a challenge, switch from your chosen relaxation technique to a short sharp phrase and repeat that phrase over and over to negotiate the ensuing discomfort. Remember to keep your phrases short (only a few simple words) and in the third person ("You" statements), so that it gives the perception of a coach or mentor directing you. This is much more powerful than trying to convince yourself using "I" statements.

Examples of breath hold mantras:

- Simple but firm counting "1234,1234,123…"
- Short third person phrases EG "You're the boss, you're the boss, you're the boss…".
- "You've got this" and "Hang in there" or "Stay with it, its only CO2", etc.

Try out a few different mantras to find the one that best works for you then stick with that one.

Lesson 12 - The Human Diving Response

The *Human Diving Response* (AKA dive reflex or mammalian dive reflex) is a set of physiological reflexes to breath holding and immersion water. The response overrides basic homeostatic reflexes and is found in various air-breathing vertebrates other than humans.

The response optimises respiration by preferentially diverting O2 stores to the heart and brain which minimises O2 consumption and enables immersion in water for extended periods of time. The response presents strongly in aquatic mammals like seals, dolphins, and whales and exists as a lesser response in other animals, including humans and diving birds such as ducks and penguins.

The diving response is triggered specifically by the need to conserve O2 during breath holds is enhanced by a cool wetting of the skin (sensors) around the nostrils, mouth and nasal cavity while breath-holding. The response is sustained by neural processes originating in carotid chemoreceptors and stimulated by lowering blood O2 levels, rising CO2 and blood acidity.

The most noticeable effects of the response on the cardiovascular system are:

- Bradycardia (Slowing of the heart rate) – triggered by immersion in cool water and rising CO2.
- Peripheral vasoconstriction (redirection of blood from extremities to the vital organs) – triggered by rising CO2
- Spleen contraction (release of O2 rich red blood cells stored in the spleen) and in humans changes in HRV. Note: Spleen contractions are also triggered by hypoxia and can also be stimulated independent of the diving response.
- Blood shift (Occurs when pressure is exerted on the body beyond 40 -50 Meters of depth, during which blood is shunted organs in the chest cavity to occupy the spaces normally filled with air when the lungs compress. The alveoli are engulfed in blood plasma from the surrounding tissues. As blood is (for our intents and purposes) an incompressible fluid when it replaces the empty space normally filled by air it protects the lungs from compression damage).

Physiological responses

When the face is submerged and water fills the nostrils, sensory receptors sensitive to wetness within the nasal cavity and other areas of the face, supply parts of the autonomic nervous system and vagus nerve with information that produces bradycardia, elicits peripheral vasoconstriction, restricts blood flow to limbs and other organs to preserve blood and O2 for the heart, brain and lungs, concentrating flow to the heart–brain circuit. This allows us to conserve O2.

Mild bradycardia is caused by holding the breath without submerging the face in water. When breathing with the face submerged the diving response increases proportionally to decreasing water temperature. However, the greatest bradycardia effect is induced when the subject is holding their breath with their face cool and wet (in water around 10°C).

Children tend to survive longer than adults when deprived of O2 underwater and it is thought, for this reason, the dive reflex is strongest in humans at birth and diminishes the more time we spend bipedal (walking and out of the water).

You can do the following simple experiment with an Oxypulsemeter and supervised by a buddy at home.

12.1 Human Dive Response demo

Fill a bucket or bowl (big enough to immerse your mouth and nose in) with cool water 5-10 °C (seems to be most effective in subjects we have used). If the water is too cold, it will provoke a Cold Shock Response and create higher stress levels that will override the dive reflex and provide a completely different response).

7. Place the bucket of water on the floor or a table where you can comfortably immerse your face (mouth and nose) in it. Note: You do not need to submerge your entire head.
8. Use an Oxypulsemeter to monitor your heart rate.
9. Relax and prepare for a breath hold.
10. Hold your breath and immerse your face in the cool water.
11. Have your buddy film the oxypulsemeter.
12. Remain in the face down breath hold position for 45 -60 seconds.

You should see a distinct drop in your heart rate through the duration of the breath hold. The drop may be as prevalent as 105bpm to high 20s in as little as 30 seconds depending upon individual nuances.

Warning: Only perform this drill in the presence of a competent buddy and cease this drill once heart rates drop into the low 30s.

Lesson Thirteen – Simulating Altitude

13.1 Hypoxia

Hypoxia is a physiological state during which part or all the body tissue is deprived of O2 .

- Can have multiple adverse signs and symptoms if chronic and involuntary.
- If used deliberately and intermittently as training tool hypoxia can provide performance adaptions.
- Pulseoximeter readings (saturation of peripheral O2) under 90 percent are considered low and hypoxic.

13.2 Cyanosis

As a person's O2 saturation drops you may notice visible changes in some areas of their skin and extremities. Cyanosis is the term used for when tissue in the relevant areas turns a bluish-purple colour. Cyanosis is most obvious in lips, nail beds, and ear lobes and occurs because of:

- Decreased O2 bound to haemoglobin
- Develops when arterial O2 drops below 85% to 75%.

Cyanosis at the end of a breath hold, may indicate the breath holder is at their limits for that day. They should be encouraged to cease from performing any subsequent breath holds or reduce the duration of the breath holds for the remainder of the session.

13.3 What is Hypoxia training (O2 deprivation)

Hypoxia is a condition in which the body or a region of the body is deprived of adequate O2 supply at a tissue level. Hypoxia may be classified as either generalised - affecting the whole body or localised - affecting a region of the body. EG brain – cerebral hypoxia. Hypoxia training is characterised by stimulating a deficiency in the amount of O2 reaching the body's tissues.

Due to its nature of depleting the body's O2 reserves, which significantly elevates the risk of cerebral hypoxia (black out), hypoxia training should only be used by for land-based training and performed by experienced breath holders and / or under supervision of a competent training buddy.

Hypoxia training builds tolerance to low O2 environments by performing an exercise or activity whilst exposing the athlete to an environment low in O2. Below is an example of a low O2 tolerance static breath hold training table.

The below static table adapts the body to lower levels of O2, by increasing breath hold length and maintaining set resting periods. The length of the last breath hold in the table should not exceed 80% of your current max breath hold, with no more than eight cycles. The following table is based on a max breath hold of 3 minutes. Total duration 30:45 min.

Hold	**Rest**
1.00	2.00
1.15	2.00
1.30	2.00
1.45	2.00
2.00	2.00
2.15	2.00
2.30	2.00
2.30	2.00

As the breath holder progresses adjust the table to suit new PBs by changing the breath hold duration to 80% of your improved breath hold time.

Note: The way an athlete breathes during their recovery can impact the hypoxic conditioning effect.

13.4 What is Hypercapnia training (CO2 Tolerance)

Hypercapnia, AKA, CO2 retention / tolerance training, consists of drills performed with higher-than-normal carbon dioxide (CO2) levels in the blood. CO2 is elevated during exercise and normally expelled through the lungs by increased breathing. When we hold our breath CO2 is not expelled and accumulates in our blood and lungs stimulating the urge to breathe. CO2 tolerance training can result in a very intense exercise experience.

Hypercapnia training adapts the body to becoming more tolerant to high levels of CO_2 and to stress generally. Hypercapnia training is characterised by maintaining high levels of O_2 saturation, coupled with short duration intervals, consisting of moderate to high activity, limited rest periods and short breath holds (high intensity interval training). This type of training significantly elevates the body's CO_2 levels, increasing the intensity of the breath hold and reducing our ability to completely off load accumulating CO_2.

It can become very intense and uncomfortable very quickly, but at the same time it is a very safe training method. Due to a strong urge to breathe, which becomes intolerable, long before O_2 is depleted to critical levels. Meaning, the breath holder will be forced to breathe long before there is any significant risk of loss of motor control (LMC / Samba) or black out.

Hypercapnia training tables are commonly used by professional freedivers (around 70% of their training load is CO_2 tolerance training) and are the most appropriate form of training for surfers. There are many flow-on adaptions from hypercapnia training for all athletes and anyone who is wishing to develop any form of stress management.

Hypercapnia training can be performed on land or in the water and is high in intensity but low in risk. Hypercapnia training is the principal breath hold technique taught on the Apnea Survival – Surf Apnea course, due to its specificity to unexpected and intense, aquatic immersions and low risk profile.

Hypercapnia training benefits include:

- Increased tolerance to high levels of CO_2
- Increased tolerance to stress
- Increased performance during high stress situations
- Enhanced exercise and breath hold recovery times
- Enhanced dive response activation
- Makes breath holds more comfortable
- Lengthens breath holds

13.4.1 Example of a hypercapnia training table

The below CO_2 static table is designed to adapt the body to higher levels of CO_2 by reducing the rest duration between fixed breath holds. The duration of the timed breath hold should not exceed 50% of your personal best (PB) and the table should consist of no more than 8 cycles. The following 8 cycles are based on a personal best static breath hold of 3 minutes. Total duration 25:15 min.

Rest	**Hold**
1.00	1.30
1.00	1.30
1.00	1.30

1.00	1.30
1.00	1.30
0.45	1.30
0.30	1.30
0.15	1.30

As you progress adjust the table to suit new personal bests by changing the breath hold duration to 50% of your improved breath hold time.

13.5 Simulated altitude training – AKA - Intermittent Hypoxic Hypercapnic Training (IHHT)

IHHT consists of a series of intervals where the athlete is either breathing air with a low O2 saturation, or performing breath holds that lower O2 saturation. The hypoxic periods are alternated with periods of ambient (normoxia) or O2 saturated (hyperoxia) air. The protocol can be repeated several times in variable-length sessions, depending on the training outcomes sought and the ability of the athlete.

IHHT has been used to improve both health and athletic performance, due to the adaptions that occur, which result in more effective and efficient oxygenation of the body.
IHHT consists of:

- A combination of deliberately lowering O2 saturation and raising CO2 in the body
- Repeated exhale breath holds (FRC – function residual capacity)
- Limited recovery periods

Increases in session intensity result in increases in the training effect and adaptations.
Below are SpO2 levels and relevant altitude equivalent.

90% SpO2 = 3 - 4000M

80% SpO2 = 4 - 5000M

70% SpO2 = 5 - 6000M

60% SpO2 = 6 – 7000M

Three interval sessions per week have been found to elicit the best adaptive response. As with any training, the intensity of the intervals will determine the duration and number of reps per set and session length. Higher intensity sessions with super low O2 saturation may consist of 1 or 2 exhale (FRC) breath hold, reverse Tabata's (1 reverse Tabata = (10sec max effort and 20 sec rest) x 8). Whereas longer duration sessions require less intensity, enabling them to be sustained over a much longer period of time. For example, up to 45 minutes.

The body responds to exposure to low O2 environments by creating adaptions that allow the body to become more efficient at functioning in low O2 scenarios. As a result, the body becomes a lot more efficient in its use of O2, which results in it being able to perform more optimally when reintroduced to O2 rich environments. Worth noting is, slow breathing and breath holds have been found to stimulate adaptions to altitude more effectively than actually training at altitude. Hypoxic environments, create the following adaptions:

- Improved tolerance to low O2
- Reduced blood acidity
- Slower metabolism
- Increased EPO production
- Increased haemoglobin production
- Production of new blood vessels, capillaries and spleen
- Increased lung mass and volume
- Increased oxygenated blood flow to brain & vital organs
- Improved metabolic function

13.6 Benefits of IHHT

- Boosts the immune function
- Flushes metabolic waste from tissue (detoxification)
- Improves metabolism
- Enhances healing / recovery (injuries and illness)
- Reduces chronic fatigue and brain fog
- Speeds up respiratory infection recovery
- Increases red blood cells / O2 carrying capacity
- Improves endurance and muscle recovery
- Slows down cognitive decline (patients with brain disorders)
- Improves performance indicators – movement efficiency, sprint repeatability, VO2 max, EPO, O2 carrying capacity of Haemoglobin and aerobic function.
- Reduces alcohol withdrawal stress

Lesson Fourteen - Altitude simulation training drills

14.1 Functional Residual Capacity (FRC) – Exhale breath holds.

The breath holding technique we use to simulate altitude training is performed following a passive exhalation. Functional Residual Capacity (FRC) refers to the air remaining in the lungs following a passive exhale. When followed by a breath hold the technique is referred to as a FRC breath hold.

FRC breath holds remove the reserve O_2 normally held in the lungs during a breath hold following an inhale. This allows a hypoxic state to be obtained more quickly than when the breath is held on an inhale, prior to any significant accumulation of CO_2. This allows the breath holder to push the breath hold deeper into hypoxia prior to being overwhelmed by the urge to breath which is generated by the accumulated of CO_2.

In a normal healthy individual, the volume of air in the lungs during FRC breath holds, is around 3 litres. FRC also represents the point of the breathing cycle where the lung tissues (alveoli) elastic recoil and out outward expansion (flex) of the chest wall are at equilibrium. FRC is unique due to it being both a measure of volume and related directly to two respiratory structures.

FRC volume is the total amount of air in the lungs at the lowest point of their tidal volume (TV). The TV is the volume of air normally inhaled and exhaled (turned over whilst breathing). FRC is a combination of both the expiratory reserve volume (ERV) and the residual volume (RV). ERV is the reserve amount of air that can be exhaled forcefully after passive exhalation and RV is the amount of air remaining in the lungs after exhaling, as much air from the lungs as possible. The RV can never be exhaled as it is the air keeping the alveoli open.

FRC can be represented as the following equation. RV+ERV= FRC.

All FRC breath holds on the Breath FX workshop are performed using nasal breathing. Nasal breathing provides greater control of the gas turn over and provides restriction to the air flow in and out of the lungs adding an additional intensity to IHHT work outs. The additional adaptions triggered by nasal breathing, also train us to maintain nasal breathing during higher intensity activity, delaying the default to using the mouth to breath and slowing recovery, reducing the elimination of both CO_2 and uptake of O_2, thereby retarding the ability to fully recover. This maintains a hypoxic state leading into subsequent breath holds and compounds the adaptive effect, resulting in greater improvements to tolerance of both high CO_2 and low O_2.

Whereas, if we were to use mouth breathing to recovery, we would be able to fully restore O_2 and CO_2 equilibriums very quickly. Or even reduce CO_2 levels below normal which can delay the impact of the hypercapnic component of IHHT.

14.1 Warm up (hypoxia session preparation)

Warm up objective - Prepare the body for altitude simulation training.

Method - Walking exhale breath holds performed to a tolerable air hunger (60-70% of maximum perceived rate of exertion (PRE))

1. Breathing only through the nose
2. Take a normal relaxed breath in and normal relaxed breath out

3. Pinch nose and hold the breath
4. Whilst holding breath, walk for 10-15 paces
5. Stop walking - recover – 5 breaths
6. Repeat 5 to 10 rounds

14.1.1 - Recovery breathing for altitude simulation warm up.

Warm up recovery breathing objective – Maintain a comfortable air hunger.

Method – Slow controlled nasal breathing.

1. Stop walking and release your nose
2. Stand in a relaxed stationary position
3. Inhale through your nose and resume relaxed nasal breathing
4. Relaxed and controlled inhales (2-3 counts)
5. Pause slightly 2-3 counts
6. Relaxed and controlled exhale long and slow (6-9 counts) pause and repeat.

14.2 Altitude Simulation Drill – Level One

Level one session objective – Lower O2, elevate CO2, create a strong air hunger

Method – Running exhale breath holds to a strong air hunger (70-85% of max PRE) with limited rest.

1. Breathing only through the nose
2. Take a normal relaxed breath in and normal relaxed breath out
3. Pinch nose closed and hold your breath
4. Whilst holding your breath jog for 40 Meters (10 sec)
5. Stop - recover - nasal breathing for 20 sec
6. Repeat 8 rounds

14.2.1 - Recovery breathing for altitude simulation drill – level one.

Level One recovery breathing objective – Ease air hunger by normalising CO2 levels and maintain moderate hypoxia.

Method – Slow controlled nasal breathing.

1. Let go of your nose and breathe in through the nose

2. Walk a few paces and stop
3. Let go of your nose and breathe in through the nose
4. First three to five breaths are very short and strong through the nose (breathe in just enough air to fill the nostrils and no more). Taking limited air into your lungs for the first breaths
5. Then, take a normal relaxed breath in and normal relaxed breath out and continue this breathing for the remainder of the recovery period.
6. Feel the air coming into your body and air leaving your body.
7. Focus on your breathing during the entire recovery period.

14.3 Altitude Simulation Drill – Level Two

Objective –Lower O2, elevate CO2, create a strong air hunger, and restrict recovery – High Intensity (IHHT)

Method – Running / row / bike / battle ropes with exhale breath holds @ high intensity air hunger (85% to Max PRE) with dynamic rest

1. Breathing only through the nose
2. Take a normal relaxed breath in and normal relaxed breath out
3. Hold breath
4. Whilst holding the breath, walk until a strong air hunger is acquired
5. When a strong air hunger is felt, continue holding the breath and move from a walk to a run
6. Continue running to break point
7. Upon reaching break point, recover by walking and breathing only through the nose for 20 sec
8. Repeat continuously for 5 -10 minutes. Scale according to skill level.

14.3.2 - Recovery breathing for altitude simulation drill – Level two

Level two recovery breathing objective – Ease air hunger by normalising CO2 levels whilst maintaining mild hypoxia.

Method – Variable, controlled nasal breathing.

1. Slow to a walking pace
2. Let go of your nose and breathe in through the nose
3. First three to five breaths are very short and strong through the nose (breathe in just enough air to fill the nostrils and no more). Taking limited air into your lungs for the first breaths
4. Take a normal relaxed breath in and normal relaxed breath out and continue this breathing for the remainder of the recovery period.
5. Feel the air coming into your body and air leaving your body.
6. Focus on your breathing during the entire recovery period.

Lesson fifteen - Stress

15.1 What is stress?

Stress is either a physiological or psychological response to a stressor. A stressor is a stress causing stimulus. A stressor can be a chemical or biological agent, environmental condition or an event that challenges or threatens an individual's safety or survival. Stress is how our bodies react to that challenge or threat.

Physiological stressors are those that you notice in your body first and include a range of physiological responses from muscle tightness (tension) to injury and illness. For example, over worked muscles can become tight and sore and that ache or muscular pain can make us irritable. When this occurs, the pain is causing a stress response. Physiological stressors can also be subtle. For example, if our body is fighting off an infection, we can be impacted both physically (aching muscles, muscular fatigue and lethargy) and mentally (brain fog and inability to focus) due to glucose and O2 (energy) - being diverted to the immune system.

Psychological stressors are those that come from your mind. For example, when sensory cues remind us of a past traumatic event (such as a near drowning experience) and cause us to ''emotionally'' re-live the experience. Which then triggers physiological changes in the body. The threat may not be real at all, but our memory recalls the old story causing us to have an emotional episode based on our experience of the past event.

Psychological stressors include, high pressure situations (expectations to perform) such as, job interviews, work deadlines or formal assessments. There is no actual physical threat but we become stressed because of the meaning we attach to the situation. For example, failing an exam or trying to deliver a presentation to meet the expectations of other people. We create the psychological tension (stress) within ourselves.

Stress can be defined by three key descriptors.

4. Physiological or psychological tension
5. Internal or external forces
6. Exceeding a person's resources for their ability to cope

Stress does have a purpose. It enables us to cope effectively with a threat and plays a critical role in our survival. However, although the stress response happens automatically, it is not always accurate. Sometimes we respond even when there is no real threat.

15.2 Our Stress response

The stress we experience can be both psychological or physiological and is triggered by the release of *stress* hormones such as, adrenaline and cortisol, via processes initiated by the hypothalamic–pituitary–adrenal (HPA) axis. During periods of stress, the production of these specific hormones triggers physical changes in the body.

These changes result in the production of additional energy and an up regulation of capabilities required to increase our performance, when responding to threats (specific stressors). This chain of reactions, triggers an increase in heart rate, blood pressure, and breathing rate. Priming the body for action and preparing it to perform under pressure.

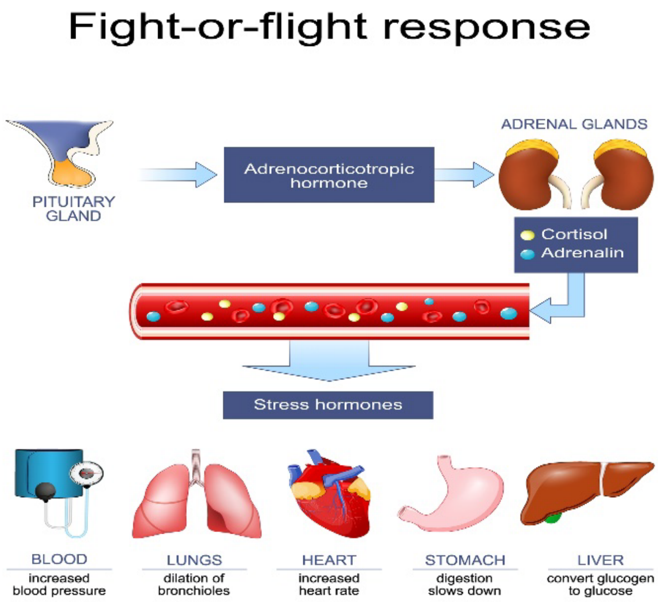
15.2.1 Changes that occur in response to stress

Psychological:

- Increased focus and attention
- Increased alertness
- Difficulty concentrating on anything away from threat
- Reprioritising of activity / function
- Reduced cognition (prefrontal cortex reduces function to increase focus on the specific threat, blood and O_2 are diverted to the midbrain, for more rapid decision making)

Physiological:

- Dilated pupils – Increase visual awareness of surroundings. Pupil dilation allows extra light into the eyes improving vision
- Pale or flushed skin- Blood flow to the surface areas of the body is reduced while flow to the muscles, brain, legs, and arms is increased. Paleness or alternating between a pale and flushed face as blood rushes to the head and brain is common.
- Blood clotting- The body's blood clotting ability increases to prevent excess blood loss in the event of injury
- Heartbeat increases - Provide the body with the energy and oxygen needed to fuel a rapid response to danger
- Respiratory rate increases – Circulates more O_2 around the body and dumps CO_2 (prolonged over breathing can also lead to hyperventilation and panic attacks)
- Trembling- Muscles tense and become primed for action
- Blood pressure - increases
- Increased cortisol production - Results in an increased availability of glucose in order to produce more energy to facilitate fighting or fleeing
- Increased adrenaline production - increases respiration, blood flow to muscles, output of the heart, pupil dilation response and blood sugar levels
- Bowels – Relax and can evacuate to save energy
- Immune system – Suppressed (not required in a fight)



15.2.2 The hypothalamic–pituitary–adrenal (HPA) axis

The body's system used to cope with stress is the hypothalamic-pituitary-adrenal axis (HPA axis) system which was first described by Physiologist Hans Selye in 1936.

The sensations of stress we experience are triggered by the release of specific hormones such as, adrenaline and cortisol, via processes initiated via the HPA axis. During periods of stress the production of these specific hormones triggers physical changes in the body that result in the production of additional energy and an up regulation of capabilities required to increase our performance when responding to a perceived threat (stressor).

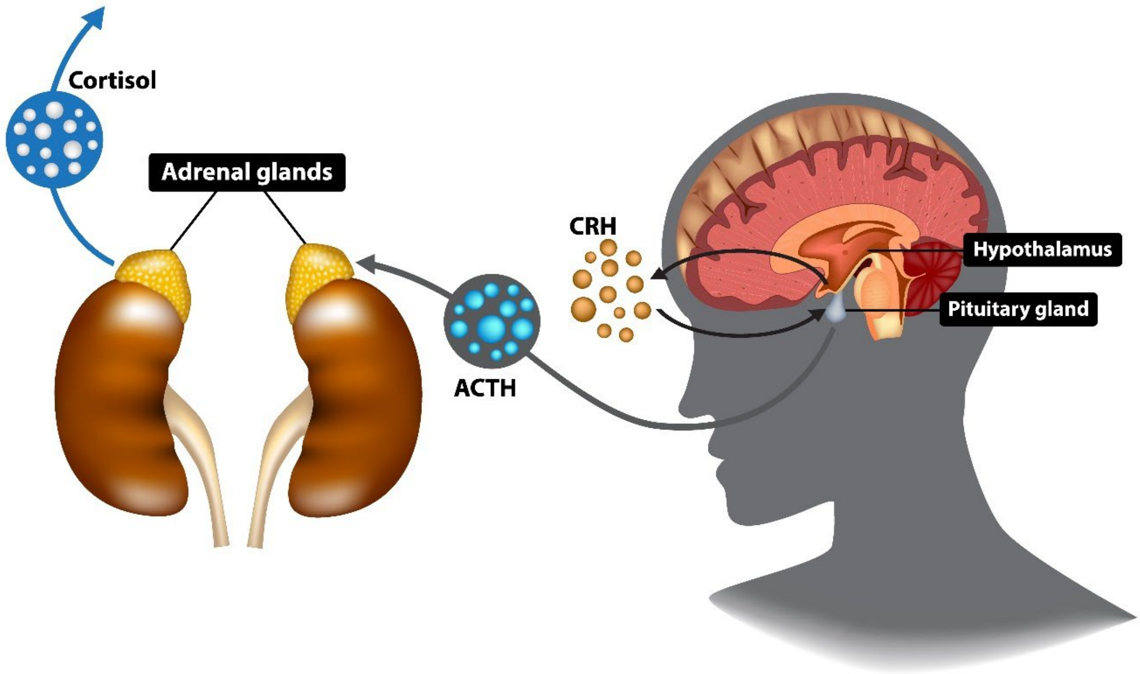
4. When you perceive a dangerous or stressful situation information is sent to an area of the brain involved in emotional processing called the amygdala. Once a threat is perceived by the amygdala, it sends a signal to another area of the brain called the hypothalamus.

5. The hypothalamus, being the command centre of the brain, then communicates with the rest of the body through the sympathetic nervous system, transmitting a signal to the adrenal glands. When the adrenal glands receive this signal, they respond by releasing adrenaline and cortisol into the bloodstream.

6. The release of adrenaline is often referred to as an "adrenaline rush". Once in the bloodstream adrenaline:
   • Binds to receptors on liver cells to break down large sugar molecules (glycogen) into more usable sugar (glucose) boosting muscle energy.

• Binds to receptors in the lungs causing us to breath faster.
• Stimulates the heart to beat faster.
• Triggers blood vessels to constrict and directs blood toward major muscle groups.
• Stimulates perspiration (cooling).
• Binds to receptors on the pancreas to inhibit the production of insulin.

Cortisol on the other hand, shuts down functions in the body which are not necessary for the immediate response to the threat. Including, the immune, digestive and reproductive systems. This is done to prioritise the body's energy for the systems that are directly involved in dealing with the present threat. The subsequent result is an increased availability of glucose for energy to facilitate fighting or fleeing.



15.2.3 Emotional hijacking (AKA Amygdala hijacking)

Emotional hijacking is a state in which our *emotions interfere with the functioning of our brain*, resulting in reactions such as, aggression or irrational fear-based behaviour.

Psychologist David Goleman introduced the concept of emotional hijacking in 1995 in his book '*Emotional Intelligence: Why It Can Matter More Than IQ*'. Referring to "amygdala hijack", Goleman wrote about how important the amygdala was because it serves as our emotional processor and can take over our behaviour and dominate the parts of our brain that normally aid rational thinking.

An amygdala hijack causes the prefrontal cortex to focus only on the perceived threat, making it difficult to think clearly, inhibiting our ability to make rational decisions. This action results in the triggering of the HPA Axis and our stress response system and is an attempt to us for fighting or fleeing. The amygdala can serve to "hijack" our brain when we are faced with a stressful / threatening situation, preparing our body to react as if we are facing a real danger to promote our ongoing survival. Although, in most cases, there may be no real or actual danger.

An emotional hijack will generally result in aggressive reactions or a panic attack. Which can pose significant consequences for both our decision-making ability and eventually our well-being. Therefore, it is crucial to recognise, the psychophysiological cues that precede a hijacking. Increased self-awareness equates to increased self-control and better decision making and better decision making increases our survivability.

It is important to distinguish the difference between being 'emotional' and being emotionally hijacking. Feeling and recognising emotions is a perfectly normal behaviour for humans. However, when our emotional processor takes over, we need to regain control. Recognising what triggers an emotional hijack allows us to intercept and control our response.

The level at which we can recognise and control our emotions is referred to as 'emotional intelligence'.   If we are an emotionally intelligent person, we have a robust connection with the emotional part of our brain and are well-tuned to our emotions and thinking. A benefit of being emotionally intelligent is a resulting increase in ability to de-escalate our emotional responses and prevent an emotional hijacking.

We can train emotional intelligence through practice, using exercises that increase awareness of the present moment, tune us into our surrounds and intercept any circular, negative and internal narrative.

15.2.4 The Emotional Audit

A tool that can help with the development of self-awareness and self-control is an "Emotional Audit." An emotional audit is a set of strategic questions that can shift our focus during emotionally charged events by activating specific areas of the brain. For example:

- *What am I thinking?* (Basal ganglia- integrates feelings, thoughts and movements).
- *What am I feeling?* (Basal ganglia- integrates feeling thoughts and movements) Temporal Lobes – emotional stability, name it to tame it – labelling affect.)
- *What do I want now?* (Cerebellum – executive functions connects to Prefrontal Cortex (PFC), cognitive integration).
- *How am I getting in my way?* Prefrontal Cortex – learning from mistakes.
- *What do I need to do differently now?* (Prefrontal Cortex –the

boss supervision of life – executive functioning planning goal setting, insight) (Anterior Cingulate Gyrus brain's gear shifter– sees options go from idea to idea).

15.3 Effect of stress

It's not always possible to prevent stress and sometimes stress can be positive and motivating. Finding the balance between stress that is productive and stress that is detrimental is the key. Unmanaged acute stress can become chronic and may cause long-term health problems. Physical symptoms of prolonged stress may present as any of the following:

7. Breathing. Involuntary over breathing (hyperventilation) is a compensatory mechanism occurring in response to changes in the body's chemistry resulting from higher levels of hormones like adrenaline and cortisol. This can lead into a myriad of ongoing health consequences, such as, high blood pressure, asthma, chronic inflammation, weight gain and heart problems.

8. Stomach (gut). When stressed we produce more glucose to provide the additional energy required to flee or fight. If this happens to frequently it can increase the risk of type 2 diabetes. Adrenaline and cortisol can also upset digestion and cause reflux.

9. Muscles. We tense in preparation for a 'fight or flight' response and to protect your body from a potential injury. After a stressful event our muscles should relax and blood pressure should return to normal. However, if we are continually exposed to stress, muscles have less opportunity to recover or relax. This can cause physical symptoms such as ongoing muscular pain. Back, neck and shoulder pain are symptoms commonly associated with chronic stress.

10. Immunity. Our immune system is stimulated to help heal wounds or injuries. Periods of stress can interfere with the function of our immune system, making us more vulnerable to infection and illness and retarding our ability to recover.

11. Skin and hair. Stress hormones increase oil production, which can make skin more sensitive and oilier and over time may cause acne or hair loss.

12. Fertility and sexuality. Ongoing chronic stress leads to your mind and body being exhausted and fatigued. This impacts the reproductive system and may reduce your desire for sex or lead to fertility problems.

Things that relieve stress.

5. Relaxation. Daily rituals that release tension in your body and your mind. EG relaxed breathing exercises for ten minutes before going to bed.

6. Exercise. Is a voluntary stressor, known for its ability to reduce involuntary stress. This is due to exercise imitating the completion of the stress response cycle (physical feat - fight or flight), which activates the down regulation of the stress response. A simple thirty-minute walk or social sports game can blow off the residual effects of stress.

7. Greater awareness.   Knowing what triggers your stress allows you to better understand and control it.

8. Greater knowledge. Learning how to control the stress cycle (recurring feedback loop).

15.4 General adaptation syndrome – G.A.S.

The General Adaptation Syndrome or G.A.S. (AKA Stress response) is the body's reaction to stress. It was originally described by Hans Selye an Austrian-born physiologist in 1936. Although he never won it, Seyle received a total of 17 Noble Peace Prize nominations for his work. Selye referred to the stress response as general because it had a ***General*** effect upon large portions of the entire body. ***Adaptive*** because it stimulated a defence to the stressor and ***Syndrome*** because it was dependant on the manifestation of an individual's nuanced reaction to the stressor.

Selye's interest in stress began when he observed patients with various chronic illnesses, like, tuberculosis and cancer, displayed common symptoms that he attributed to what we now know as stress. Selye also observed similar responses in laboratory animals. For example. Rats exposed to cold, drugs, or physical injury, exhibited a common pattern of responses to these events (stressors).

Selye later changed the term G.A.S. to "stress response" and argued that stress differs from other physical responses in that the stress response is identical, regardless of whether the provoking stressor is positive or negative. He called negative stress "distress" and positive stress "eustress".

Seyle gave G.A.S. 3 distinct phases.

4. Alarm reaction - Immediate reaction to the stressor. EG Fight flight or freeze.

5. Resistance / adaption - During this phase the body makes changes on many levels to reduce the effect of the stressor. That is, it adapts to the stress it is exposed to.

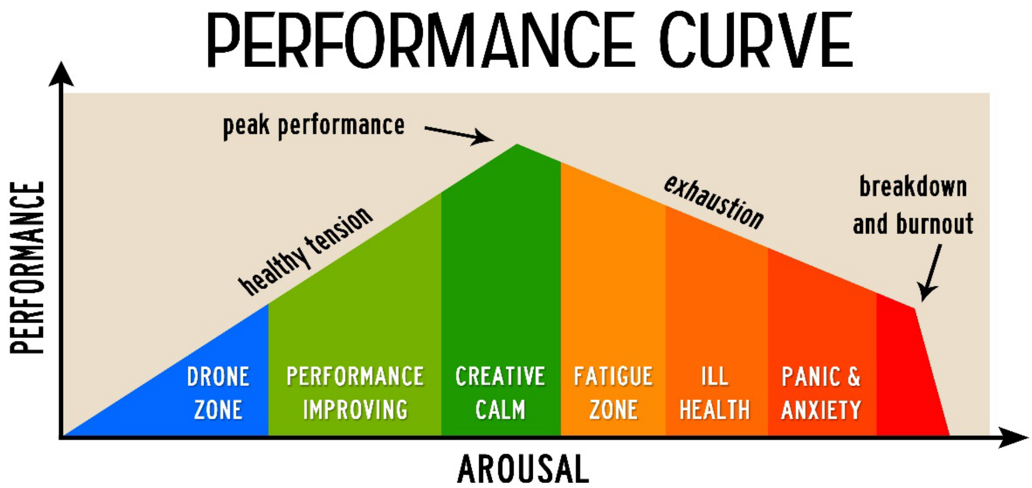
6. Exhaustion - The body's resistance to the stress may be reduced or may eventually be overwhelmed. EG a stressful job may cause long-term mental stress that results in a physiological shut down of all systems. AKA burn out, chronic disease or heart attack.

Selye observed people's perceptions of stress impacted the way their bodies responded to it. He believed people's perceptive responses were at times more dangerous than the actual stressors themselves.

All performance-based activity / training is about stress adaption. Whether you're breathing, not breathing, moving, lifting, bending, or mobilising or whatever. The intent is to provide a repeated stress, that encourages your body's systems to adjust and cope with the environmental change to maintain its homeostasis. Hence, it is important for any training program to be balanced with the optimal ratio of stress and recovery and to be particularised to the requirements and ability of the individual. Not enough stress can result in poor or no adaption. Too much stress can result in system breakdown.

"It is not stress that kills us. It is our reaction to it" – *Hans Seyle*

The diagram below is based on the *Yerkes Dodson Stress Performance Curve* and explains how some stress can be beneficial to our performance but too much can overwhelm us.



Lesson sixteen - Fear

16.1 Definition of fear

Used as a noun fear is given the following meaning by the Merriam Webster dictionary.

"An unpleasant often strong emotion caused by anticipation or awareness of danger and to experience anxious concern or reason for alarm."

As a verb fear is given the following meaning by the Merriam Webster dictionary.

"To be afraid or feel fear."

Stress, fear and anxiety can be quite similar. You feel fear in response to danger and experience stress. Later, you may experience anxiety when you again experience the same symptoms associated with your initial response but now it occurs in the absence of any present danger. Fear can be referred to as '*the anticipation of a perceived outcome'*. This perception being based on what our memory recollects from similar past events and experiences and what we believe may result from current circumstances based on that experience.

Fear is experienced as an unpleasant emotion (feeling), which arrives in response to how we *perceive* a situation as being a danger or threat to our survival (although the danger may not actually be real). Fear provokes our stress response which subsequently triggers physiological changes and later, behavioural reactions, such as, fighting or fleeing. These sensations can feed a self- perpetuating cycle of fear and stress, increasing the perception of impending doom and distorting further the genuineness of the any real threat or lack thereof.

Fear is nicely tied into our stress response and modulated by cognition and learning. It can also be deemed as either rational (appropriate) or irrational (inappropriate). A phobia for example, is an irrational fear as there is no real danger present to warrant a fight or flight reaction. We can sum fear up as a feeling of 'unease' or 'apprehensiveness' in response to an event we perceive as an imminent threat. This response has been preserved within us throughout evolution as a survival mechanism and can be either conditioned or unlearned but never made extinct.

We can condition our fear by reinforcing it through our behaviour. EG if we are afraid of suffocating whilst holding our breath, our defence mechanisms are being conditioned to that perceived danger. Such behaviour further supports our belief (perception) that the danger is real.

We cannot entirely extinguish our fears but we can unlearn them. Through incremental and progressive exposure to small and tolerable doses of the relevant stressor. This is the basis for *hormesis*, a characteristic of organisms, used to adapt, through small doses of exposure to increasing amounts of a stressor. That is, small doses of a stressor can be favourable even though a large dose may be detrimental. So going back to our breath hold and suffocation example, by regularly experiencing slightly more challenging breath holds than we are normally comfortable with (about 4% above our current skill level), we can learn to tolerate higher stress loads, which results in us becoming more comfortable with more challenging breath holds.

The flow on effect of hormesis in relation to fear is that we come to realise the reality of the danger and can better manage ourselves when exposed to that stressor (behavioural conditioning). In other words, we adapt.

16.2 Pavlov's dogs – Behavioural conditioning

Pavlov's dog experiment provides a great example of how behaviour can be conditioned. Behavioural conditioning- AKA Pavlovian Conditioning / Pavlov's Dogs Experiment. Below is an extract from Spall, B. (2020, May 29). Pavlovian Conditioning: Ivan Pavlov's Dogs Experiment. https://benjaminspall.com/pavlov-dogs which describes the behavioural conditioning discovery made by Ivan Pavlov.

Pavlov (1849-1936) won the Nobel Prize in Physiology or Medicine in 1904 for his work on the physiology of digestion. Pavlov's most well-known contribution to science was through his dog experiments, which became the basis for Pavlovian conditioning (AKA classical conditioning).

Pavlov's dog experiment took place in the 1890s. Small tubes were implanted into the cheeks of dogs to measure the build-up of saliva under a variety of conditions. The experiment came about as part of an accidental discovery. Pavlov had at the time been conducting research experiments into the dogs' gastric systems. As part of this research, Pavlov and his assistants would enter the room where the dogs were housed with a variety of edible and non-edible items, with the intention of measuring the amount of saliva that each dog produced when each item was placed in front of them.

Pavlov's prediction that the dogs would salivate when presented with edible items was soon proved correct. This represents an unconditioned response, in which the sight and smell of the food causes them to salivate. While conducting his gastric experiment, Pavlov noticed something else about his dogs. He noticed the dogs would begin salivating not when food was placed in front of them, but when they heard the footsteps of the lab assistant coming down the hall to bring food to them. Pavlov soon realised he could teach his dogs to associate almost any sound, item, or event with the reward of food. The salivation was a conditioned response.

The most famous item used in Pavlov's experiment was a bell. Pavlov would ring a bell before feeding his dogs. The single act of ringing the bell was enough for the dogs to associate the ringing with the delivery of food. In the same way that unconditioned stimulus causes an unconditioned response, Pavlov confirmed the commonly agreed-upon theory that a neutral stimulus causes no response. An example of this was the act of Pavlov ringing the bell before dogs had been conditioned to the bell ringing preceding food. If the bell was rung while it was still a neutral stimulus there was no salivation. IE no response occurred.

16.3 Managing fear

Fear can never be extinguished entirely but it can be unlearned and our responses to the stressors that trigger it can be managed. Part of this process is recognising the stressor responsible for generating the fear we experience and developing a greater tolerance to the stressor. For example, our initial fear of thinking we will die from hypoxia, when we first experience the urge to breathe while holding our breath, is an example of how fear is conditioned. Once we develop a tolerance to the provoking stressor (CO2), through understanding our physiology (education) and incremental exposure to that stressor (hormesis / training), the stressor causes less stress and any fear of being suffocated whilst holding our breath is reduced.

Steps to controlling fear.

6. Accept fear is a necessary survival tool and is always going to be a part of life.
7. Rationalise all components of situations that provoke fear and understand the real nature of the danger (if any).
8. Mentally work through worst case scenarios and outcomes without any attached emotion. Use visualisation techniques to put yourself in these scenarios with favourable outcomes.
9. Identify the triggers (stressors) of your fear and challenge them through progressive and controlled exposure (practise / training - create adaptations).
10. Gradually progress training from controlled simulation to real life situations. Use small steps that reinforce successful outcomes.

16.4 Comfort Zone

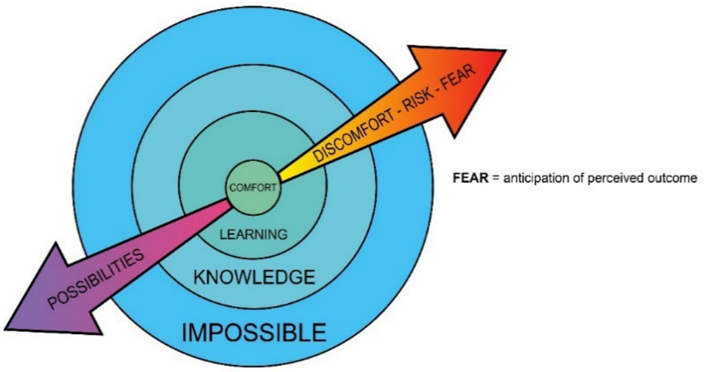
The concept of the *comfort zone* became popular in the 1990s after it was coined by management thinker Judith Bardwick in her 1991 work, *Danger in the Comfort Zone*. She referred to the *comfort zone as:*

" A behavioural state within which a person operates in an anxiety-neutral condition, using a limited set of behaviours to deliver a steady level of performance, usually without a sense of risk."

Within the comfort zone we experience feelings of familairity, feel at ease, in control and have low stress levels. Here we feel safe, secure and comforatble with both our physiological and psychological state. However, comfort zones can lead to a mental stagnation (drone zone) brought on by the fear of any form form of risk taking that might remove us from the zone. Fear and lack of motivation, can result if we do not challenge the boundaries of the zone by exposure ourselves to stress.

Graphically we can think of a comfort zone as a circle that contains everything that we are at ease with doing inside. These are likely the things that are percieved as being risk free and which we find easy to do. Outside of the circle are all the things that cause us stress or fear. Such things, however, are also the things that result in growth, development of new skills and new experiences. The very things that enrich life. For any individual to grow they need to challenge their fears, experience stress and learn to navigate the temporary discomfort that comes with experiences outside the comfort zone.

COMFORT ZONE

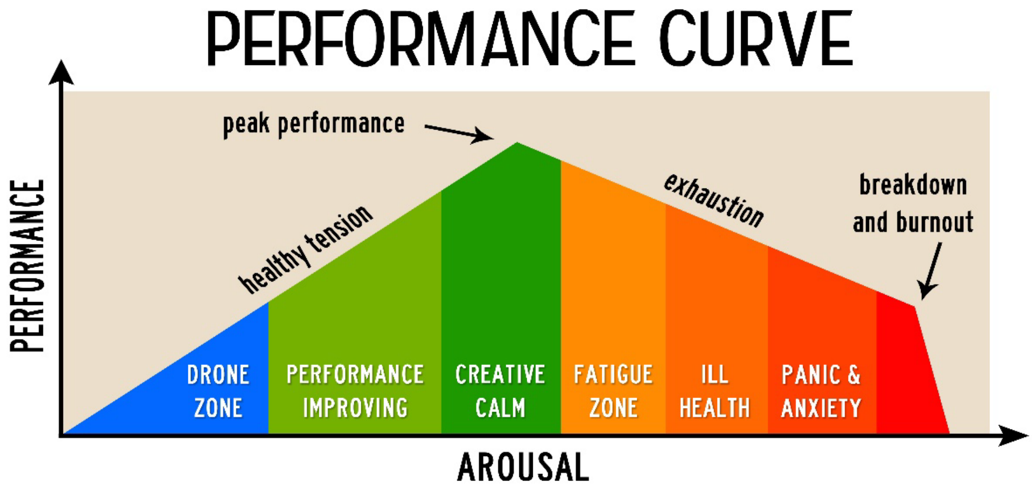


The risks assocaited with leaving the the comfort zone are perceived by us as threats and our body will respond to them in the same way it does with any other threat. However, when we challenge those perceptions and adapt to that stress, we become more comfortable with discomfort.

Robert Yerkes and John Dodson studied the relationship between stress and performance in the early 1900s. Their empirical analysis resulted in The *Yerkes–Dodson law.* The law dictates that performance increases with physiological or psychological arousal, until the arousal becomes too high, upon which performance decreases. Confirming stress in the right doses can be beneficial (hormesis).

The core idea or the Yerkes – Dodson law is that our nervous system has a 'Goldilocks' zone. Not enough arousal and we get stuck in your comfort zone and boredom takes over and with too much arousal we enter the 'panic' zone, which can also pause progress.

The law can be graphically represented by the Yerkes Dodson Stress Performance Curve as per the below diagram.



"Insanity is doing the same things over and over again, expecting different results" – Albert Einstien

Lesson seventeen – Deliberate Cold Exposure

17.1 What is deliberate Cold Exposure?

Deliberate Cold Exposure (DCE) is when we intentionally expose our bodies to cold water (temperatures <15°C), with the intention of gaining some a health and performance benefit. The voluntary nature of the exposure and the cold are both believed to have many health and performance benefits. For example, improving the body's natural ability to recovery from stress.

DCE has been around for millennia with many ancient cultures having some reference to its use and benefits. A commonly used form of cold exposure is Cold Water Immersion (CWI). Cold water immersion techniques include things such as, standing under waterfalls, plunging into frozen lakes, sitting in tubs of iced water, or simply taking a cold shower.

DCE is thought to be a gateway to activating our body's natural healing power. When undertaken regularly, the effects of cold exposure can be long lasting. For example, it is suggested that over time, with specific protocols DCE can improve circulation, reduce muscle inflammation and soreness, increase general resilience to stress, develop mental grit, balance and regulate hormones and facilitate weight loss.

17.2 Cold Water Shock Response AKA Cold Water Immersion Syndrome

The cold water shock response is a series of neurogenic (controlled by the nervous system), cardio-respiratory responses caused by sudden immersion in cold water.

Cold-water shock (CWS) is the first stage in the body's response to being suddenly and unexpectedly, immersed in cold water (15 °C or less). CWS occurs during the first sixty seconds of exposure. It is thought, CWS causes more deaths than hypothermia.

When suddenly immersed in cold water the sympathetic nervous system is upregulated to defend the body against the threat (cold). This activates the HPA axis and delivery of stress hormones adrenaline, cortisol and dopamine throughout the body. Which in turn, creates a cascade of physiological reactions causing the body to immediately react with involuntary gasping, muscle spasms, hyperventilation, increased heart rate, increased pulse, and increased blood pressure. In extreme cases CWS can cause instant muscle paralysis or cardiac arrest. The involuntary gasp reflex can also progress to loss of airway control resulting in an immersed person drowning.

Death, which can occur in such scenarios is complex to investigate and may have several possible causes and several phenomena occurring simultaneously. Cold water can cause heart attacks, due to severe vasoconstriction and the heart having to work much harder to pump the same volume of blood throughout the body. Other cold shock responses include:

- For people with pre-existing cardiovascular disease, the additional workload can result in myocardial infarction and/or acute heart failure, which ultimately may lead to a cardiac arrest.
- A vagal response to an extreme cold may, in rare cases, render *per se* a cardiac arrest.
- Hypothermia and extreme stress can both precipitate fatal tachyarrhythmias.
- A more modern view suggests that an autonomic conflict between the sympathetic and parasympathetic nervous system, due to the coactivation of the human diving response, may be responsible for some deaths.
- Gasp reflex and uncontrollable tachypnoea (rapid shallow breathing) can severely increase the risk of water ingress to the airways and subsequent drowning.
- Individuals can increase their function and survivability in cold water through regular and progressive cold exposure (hormesis / training). Progressive training adapts the body to cold water exposure by creating physiological, physiological and biological upgrades, that enable the trained person to better tolerate exposure to cold.

17.2.1 The phases of the cold-water immersion syndrome

The first stage of cold-water immersion syndrome, the cold shock response, includes a group of reflexes lasting under 5 min and initiated by thermoreceptors, sensing rapid skin cooling.

Water has a thermal conductivity 25 times that of air and a volume-specific heat capacity over 3000 times that of air (ability to maintain its temperature) subsequently, surface cooling is sudden.

The primary components of the CWIS include an involuntary gasp, tachypnoea (shallow, rapid breathing) and peripheral vasoconstriction. Peripheral vasoconstriction is a result of heat preservation via central blood shunting. The magnitude of the CWIS is impacted by the cooling rate of the skin, and its termination is likely due to reflex baroreceptor responses or thermoreceptor tolerance.

The physiological response to sudden immersion in cold water, can be divided in four phases, with different risks and physiological changes, collectively forming Cold Water Immersion Syndrome (CWIS). Although this process is a continuum, the 4 phases are as follows:

Phase 1. Initial shock (1 to 2 Minutes)

An initial deep and sudden gasp followed by hyperventilation, that can be as much as 600-1000% greater than normal breathing rate. The initial shock will pass in about 1 minute. During that time anyone in cold water should concentrate on avoiding panic and maintaining control of their breathing.

Phase 2. Incapacitation (10 Minutes)

Following Cold Shock, the next ten minutes will result in loss of fine motor control in the extremities. That is, fingers, arms and legs, etc become difficult to use for any meaningful movement. Keeping the airways clear of the water will increase in difficulty as time progresses. Swim failure will occur within this period and if a person is not rescued, drowning is likely.

Phase 3. Hypothermia (30 minutes plus)

Even in 3 - 5°C or less it could take up to 1 hour for a person to become unconscious due to Hypothermia.

Phase 4. Circum-rescue collapse

Circum-rescue collapse is a complex physiological phenomenon that can occur immediately before, during or after a person is removed or rescued from cold water. The symptoms can range from fainting to cardiac arrest.

Circum-rescue collapse occurs when the body experiences a lack of ability to maintain heart function, blood pressure, and core temperature, because of the stress created by CWI and / or any demanding physical requirements of removal / rescue from cold water. The condition was well documented during World War II, when it was found that a safe and successful recovery of a downed pilot or sailor was greatly enhanced when the patient was maintained in a horizontal position.

As opposed to being vertical when lifted (using an under-arm sling or life ring) from the water. Thereby, relieving some of the strain on the heart caused by blood rushing to the lowest point of the body when it is lifted from cold water. If a CWIS victim is placed in a vertical position it causes the blood to pool in the legs and decreases blood pressure further. The combination of a cooling heart and increased cardiac work to maintain blood pressure may cause symptoms ranging from fainting to cardiac arrest.

In some cases, the consequence of rapid body cooling, may cause the heart to continue to cool until it reaches the temperature threshold for spontaneous cardiac arrest. Stress hormones may also play a role. These hormones increase muscle strength and help maintain blood pressure during cooling / CWI. However, the process may decrease stress hormones, due to mental relaxation and cause a subsequent decrease in blood pressure.

Phase	Time	Physiological Changes
Initial shock	First 1-2 minutes	Cooling of the skin, hyperventilation, tachycardia, gasp reflex
Incapacitation	After 3 minutes	Superficial neuromuscular cooling
Hypothermia	After 30 min	Hypothermia, later collapse
Circum-rescue collapse (after drop)	Immediately before, during or after rescue	Cardiac arrythmia, haemostasis (coagulation / bleeding ceases), unconsciousness

Farstad, David J.; Dunn, Julie A. (September 2019). "Cold Water Immersion Syndrome and Whitewater Recreation Fatalities". Wilderness & Environmental Medicine. 30 (3): 321–327. doi:10.1016/j.wem.2019.03.005. ISSN 1545-1534. PMID 31178366. S2CID 182948780.

https://ussartf.org/cold_water_survival.htm

17.3 Benefits of CWI

Survival time in water without protective clothing		
Water Temperature	**Exhaustion or Unconsciousness**	**Expected Survival Time**
70–80° F (21–27° C)	3–12 hours	3 hours – indefinitely
60–70° F (16–21° C)	2–7 hours	2–40 hours
50–60° F (10–16° C)	1–2 hours	1–6 hours
40–50° F (4–10° C)	30–60 minutes	1–3 hours
32.5–40° F (0–4° C)	15–30 minutes	30–90 minutes
<32° F (<0° C)	Under 15 minutes	Under 15–45 minutes

Dropping into tubs of ice and water has become a thing to do ever since the charismatic Dutchman, Wim Hof, popularised it. You can now ask any ice plunging fanatic, why they do it and they will either rattle off a string of purported benefit claims but also struggle to validate those claims with references to any science. Or they'll be completely lost for an explanation when attempting to describe what motivates their addiction to the cold. Other than it feels amazing.

From longevity to improved metabolism, CWI seems to cure it all. Some eczema sufferers have even found regular CWI to help their flare-ups, now swearing by the ritual. CWI results in a natural buzz (feeling of euphoria), although only coming into popularity in recent history, its actually been raved about for centuries. Hippocrates is the oldest known and recorded mega-fan of a CWI. Having documented his experiences back in 370 BC.

Nowadays, CWI is included in the celebrity workouts of world famous stars like Chris Hemsworth and Madonna and touted to as having a heap of health and performance benefits. So, what **are the benefits of CWI?**

CWI benefits are still hotly debated amongst the 'scientific' world and CWI still sits closer to the edge of the woo woo, wellness territory than concrete 'science' (if there is such a thing).

So much of the evidence is still anecdotal. However, this does not suggest it should be disregarded it simply means it has not been studied with any vigour. And even the studies that have been done are small and used specific protocols that elicited specific outcomes. Regardless, many high performers swear by CWI for improving recovery and down regulating stress.

Other CWI benefits include:

- Boosting the immune system
- Improving circulation
- Deepening sleep
- Boosting energy levels
- Reducing inflammation
- Reducing muscle soreness
- Analgesic effect on pain
- Improving metabolic function
- Improving mood
- Regulating hormones
- Body fat reduction (weight loss)
- Recovery from addiction
- Builds grit and resilience
- Reduces mental illness (depression and anxiety)
- Greater cooling during exercise which results in increased and more sustained maximum exertion output (endurance and power)
- Increases self-discipline
- Develops increased grit and resilience

17.3 How CWI works?

Deliberate CWI is basically a way of voluntarily exposing our body to the extreme stress associated with an unintended cold-water immersion. Due to the sympathetic nature of the cold shock response, we are voluntarily activating the sympathetic nervous system when we deliberately plunge into a tub of ice.

With this activation comes a cascade of physiological adjustments triggered by the HPA axis to enable us to fight or flee the threat of extreme cold.

CWI -> cold shock -> stress response -> HPA axis

Below are some of the changes found to occur when the body is exposed to cold water (14°C or less) resulting from increased activation of the Sympathetic Nervous System:

- Increased metabolic rate (350%),
- Increased heart rate (5%)
- Increased breath rate (gasp reflex / hyperventilation)

- Increased systolic and diastolic blood pressure (7%, and 8%, respectively).
- Increased plasma noradrenaline (530%)
- Increased dopamine concentrations (250%)
- Increased diuresis (163%)
- Plasma aldosterone concentrations increased by 23%.
- Cortisol concentrations tended to decrease (apparent with any deliberate stress exposure).

Human physiological responses to immersion into water of different temperatures (European Journal of Applied Physiology)

Increasing Energy

Everybody has their own method for waking themselves up in the morning. Some folks head for a caffeine hit, a quick H.I.T. work out, etc. However, CWI may be a more efficient alternative. CWI triggers the production of the neurotransmitter norepinephrine, a critical chemical in the body that plays a role in regulating attention, focus, and energy. Daily CWI can increase norepinephrine and simultaneously boost energy.

Resilience

CWI can push the limits of your mind in the same manner any intense exercise pushes our limits. Each time you return to the challenge it gets a little easier and eventually we crave the sensation and, in the process, we have increased our mental and physical toughness (grit).

Physical Recovery

Sports science has utilised CWI to aid active recovery of muscles. Research has demonstrated a connection between cold exposure and blood vessel constriction (vasoconstriction). That is, when we enter cold water, our blood vessels will shrink, forcing blood flow to vital organs. After removing the cold exposure, our blood vessels re-open (vasodilation), improving circulation and flushing out the immune system.

Discipline

CWI is challenging and requires self-control and self-discipline to continue as a regular practise. At first the thought of a daily CWI can be daunting and might not seem an easy thing to stick to and develop as a routine. However, starting off with small manageable doses as a daily ritual will ensure the stress created by the activity itself and time taken to perform are both manageable. Even if it's only a cold shower, do it and make it regular. Create the habit. Once you have created the habit with CWI you may find you can implement the same strategy to turn other challenging activities routine.

Mood

The hormone norepinephrine which is released during CWI is a regulator of mood and energy. Researchers have found that the elevated mood and energy generated through the production of additional nor adrenaline can remain for days to weeks following CWI. Further it has been found that a lack of noradrenaline can contribute to depression. CWI has been found to reverse effects of depression and other brain degenerative diseases like Alzheimer's. Although research is still new in this area there is ample anecdotal evidence CWI boosts mood regulating endorphins.

Relaxation and sleep

During CWI your autonomic nervous system is stimulated. This system is a network of vessels and nerves, split into two parts that control your response to stress. The first part, the sympathetic nervous system, triggers your "fight or flight" response, while the second part, the parasympathetic nervous system, helps to shut it down once the stress has passed. By enduring this stress, regular CWI can regulate both these systems. When we can control our response to stress during CWI, we can also control our ability to down regulate the autonomic nervous system, increasing our ability to relax and sleep.

CWI in Summary

Some medical professionals and scientists have gone as far as calling CWI "the elixir of life." Due to laboratory supported discoveries, that cold, for short periods, using water or not, appears to extend life expectancy. Being exposed to uncomfortably low temperatures, seems to activate a genetic response that upregulates the sympathetic nervous system, initiating a process during which DNA is repaired before new cells are created. CWI has also been found to promote positive metabolic changes that can aid with treatment of skin conditions, such as acne and eczema. A study on cyclists from 2011 concluded that CWI reduces the symptoms of delayed onset muscle soreness (DOMS).

Cold can help numb pain, by constricting blood vessels, which in turn helps to reduce swelling. There is an increasing body of research on the benefits of being CWI and how to stimulate brown fat (which is a more efficient energy source than white fat) and how CWI may convert white fat to brown, which is how CWI contributes to weight loss.

Why CWI hasn't been more rigorously studied or explored as a disease management tool, is because it is relatively free and available to anyone and everyone just about anywhere. This makes funding for research a challenge, as there is little to no financial profit to be made through patents or sales of a product.

17.4 Getting started.

If you want to reap the benefits of CWI you need to get comfortable with being uncomfortable. Due to the neurobiological factors that are ramped up with the stress of feeling cold, the effects of CWI are reduced the less stress it causes. So, we never want to get completely comfortable with CWI.

When starting out the easiest and safest way can be to begin with a daily cold shower. This can be broken down into incremental progressions based on an individual's base line tolerance to cold. For example:

- After having showered at a normal temperature gradually turn off the hot water and remain under the cold running water for as long as tolerable. 2 – 5 minutes on average should do it.
- The aim is to get to the water temperature where the uncomfortable feeling lasts and doesn't subside. This is when the benefits occur.
- The goal is to hold out for as long as you can but no longer than 2-5 minutes on your first go.
- Once you can tolerate the cold shower start migrating to a tub of iced water or a large bucket big enough to stand in. Start by standing in the tub or cooling the bottoms of the feet, hands and face / forehead. These areas of the body are sensitive to cold water and stimulate the same mechanisms activated during full immersion in a tub of ice. Although the response is less dramatic.
- Eventually the time will come for full commitment and full immersion. It is possible to incrementally progress full immersion using time and temperature. Temperature can be adjusted manually by adjusting the ice to water ration. Or, if your set up has a thermostat, adjust the temperature setting, etc. Time is much the same. Start off aiming for 30 seconds of full immersion and gradually increase the time until you're punching the numbers you want.

CWI beginner tips:

1. Take it slow. CWI can be a stressful experience for the unseasoned. So, ease into a routine.

2. Get familiar with the feeling of being cold and uncomfortable.

3. Normalise it into your everyday life. Form a daily ritual and expose yourself to CWI every day. Even if it is only blast at the end of a daily shower or face washing.

4. Time and persistence are what create adaptations and results.

17.4 Why we use CWI in Breath FX

During the Breath FX workshop, we use cold immersion, as a stress evoking tool, to teach specific stress control breathing techniques. For the uninitiated the anticipation alone can fire up their HPA axis. Cold water is such a great leveller for group dynamics and a guaranteed stressor. The water we use is typically around 5°C range and exposures are capped at two minutes. Two minutes is achievable for most people, it provides a good time frame for a participant to become aware of their body's responses and to implement self-control tools to control the response.

The aim is not for the participant to counter the cold by ramping their body temperature or sympathetic system prior to entering the water. It is to have the participant use focussed breathing, to intercept the recurring feedback loop and maintain a calm and relaxed state prior to entering the water. Once in the cold water, the participant uses the same focussed breathing to control their urge to gasp and hyperventilate and to shift their attention away from cold thoughts.

Participants are not permitted to use any technique that stimulates additional warmth before the dunk. Apart from a prescribed breathing protocol to calm their nerves and accept the challenge. The entire point is for them to use breathing to control their mind and body's response to the stress created by the cold. Not to ramp up hormones and core temperature to ease the impact of the cold.

With a little regular practise, it is very easy sit motionless and punch out 3–5 minute immersions in 3-5°C water.   When we sit still in cold water, we create a thermal layer around our body which forms a barrier against the cold. However, with a little subtle movement, we can disrupt this barrier and drastically increase the intensity of the experience. If you're doing more than 2 minutes, try adding some motion to the water. Swirl it with your hands. Even a light swirl can bump you out of your comfort zone. Better still dunk the head under occassionally.

If the swirling or head dunking results in a change in breath rate / gasping, return focus to your breathing. Regain control over your breathing, shift your focus away from the cold. For example, as you inhale and exhale watch the water level against the side of the tub changing.

17.5 Breathing for CWI

The technique used in the Breath FX Workshop to maintain relaxation during cold immersion is a variation of the Full Lung Breathing drill called Full Lung Resonant Breathing. This breathing technique can induce deep relaxation and for stress control, can be complimented with a relaxation technique or mantra.

1. Lay in a supine position on the floor or sit comfortably.
2. Breathe only through the nose using your natural resting breath cadence.
3. Remember to think of the torso as a 360° cylinder. All sides need to expand during the inhale and then contract during the exhale.
4. Inhale for a count of 3-5 and exhale for a count of 9-15 or whatever you're comfortable with. Note: when exhaling you are releasing the same amount of air as you inhaled, but slower and with more control. If you're not able to perform 5/15 try 2/6 or 3/9. Wherever you fall, try as best you can to maintain the ratio of 1:3 for Inhale : Exhale.
5. Still breathing through the nose only. Combine all stomach, ribs and chest into one single movement while inhaling and exhaling. Once you've got the hang of this focus

on the timing of your breath. Inhaling for 4-5 counts, slight pause then exhaling gently and controlled for 10-15 counts followed by another pause at the bottom of the exhale then inhale again.
6. Soften and quieten your breathing as you get deeper into the drill. Try to make it so soft and gentle it is undetectable. Remove the emphasis on the mechanics and inflation of the chest.
7. Aim to reduce breath cadence to 3-5 cycles per minute. As breathing is lowered, slowed and lengthened, mechanical movement will also reduce and breathing should become more subtle as your relaxation deepens.
8. When you are ready enter the cold water.
9. Once in the cold water submerge yourself up to the neck so that your chin is on the water surface.
10. Focus on the water level of the tub.
11. Watch it change as you inhale and exhale.
12. Slow your breathing as much as possible to counter the gasp reflex.
13. Keep your hands under the water.
14. Bring them together join the fingertips or form a prayer position and become aware of your fingers touching.
15. Implement a relaxation technique. This can be as simple as focussing on the sensation of air flowing in and out of your body as you inhale and exhale.
16. Slow your breathing as much as possible. Focus on a long passive exhale followed by a lengthened pause.
17. Aim to maintain gentle and silent breathing.
18. Focus on the water level again rising and falling with your breath.
19. Try to slow the rise and fall of the water so it is virtually undetectable.
20. Continue for the duration of the immersion.

17.6 Recovery from CWI

Exercise caution when exiting the cold water. Sometimes a person may experience a reduction in function of their extremities due to the peripheral vasoconstriction and shunting of blood to the body's core and vital organs.

- Do not run, jump, or perform vigorous activity immediately upon exiting the cold water.
- Do not immediately enter hot water.
- Lay flat on the ground and continue full lung relaxation breathing.
- If you're unable to lay still or sit relaxed. Walk around at a normal walking pace and allow your body to gradually warm up. If you are outdoors walking in the sun is a great way to regain heat.
- Be aware of the euphoria that may be experienced when exiting the cold water. This is a result of the dopamine dump (250%) that can last up to two hours. There are also suggestions that Dimethyltryptamine (DMT) is occasionally released in the lungs

during cold exposure. DMT combined with the massive dopamine dump may account for the hallucinations some people report after exiting the cold water.
- If hallucinations are experienced lay in a supine position and savour the moment. Feelings of euphoria may last as long as 20 minutes.

17.7 Hypoxic - nervous system reset drill

The hypoxic reset drill uses a combination of superventilation, breath hold and resonant breathing techniques to create a detoxifying and recalibration effect on all systems in the body.

Superventilation

Strong full inhale through the nose and strong full exhale through the mouth as fast as possible.

- Stretches the lung tissues and breathing musculature, maximising O2 uptake and off-loading CO2. Increasing pH and alkalising blood.
- Retards Bohr effect causing systemic hypoxia.
- Unloading of CO2 delays the urge to breath during the subsequent breath holds allowing the body to reach a state of hypoxia before the breath hold break point is reached.

Breath holds

Functional residual capacity (FRC / exhale) breath hold:

- Upon final superventilation, inhale through the nose then passively exhale through the nose. Pinch the nostrils closed and hold.
- Hold until strong urge to breathe / break point is reached.

Inhale breath hold:

- Upon reaching break point on the FRC hold, release pinching of nostrils and perform a single inhale through the nose before pinching the nostrils closed again and holding the breath (this time on the inhale).
- Continue holding until a strong urge to breathe / break point is reached.

The first breath hold, performed with low CO2 (respiratory alkalosis) on the exhale creates an environment conducive to stimulating systemic hypoxia, prior to the break point of the breath hold being reached.

The second breath hold, performed immediately on a single inhale through the nose, following the FRC breath hold, replenishes the partial pressure of O2 in the lungs enhancing the diffusion of O2 into an already hypoxic environment.

O2 levels are immediately replenished. However, CO2 has not been released which enables the Bohr effect to be stimulated enhancing the delivery of O2 at a cellular level. Eventually O2 obtained from the single breath in is depleted and the body returns reasonably quickly to a systemic state of hypoxia prior to CO_2 levels reaching a point to force a break in the breath hold.

This technique enables us to evoke an extreme level of prolonged hypoxia not obtainable or sustainable during using conventional breath hold techniques

Resonant frequency breathing (RFB)

RFB is breathing at a slow relaxed rate in and out through the nose at a pace between 3-5 breath cycles per minute.

- Upon reaching break point exhale passively and with control through the nose
- Commence slow nasal breathing at a natural relaxed cadence
- Resist any urge to breathe hard or gasp.

RFB is used as a recovery tool for this drill. Training the breath holder to master control of their breathing following what can be a powerful breath hold. Resisting the urge to gasp and restricting breathing to slow nasal breathing reduces the speed at which the body can recover from hypoxia but also recalibrates our entire system.

The combination of these three techniques into a drill containing several rounds (20-30 minutes depending on breath hold length) creates a very powerful stress control training tool. Whereby, we are deliberately subject the body and mind to high biomechanical, biochemical and psychophysiological stress and control that stress intermittently, using slow controlled nasal breathing.

The sequence:

- Nasal / Mouth superventilation 60 sec
- FRC exhale hold to break point then a single inhale through the nose (do not exhale at all) and hold again to break point
- RFB nasal 60 sec.
- Repeat x 5 rounds
- At the conclusion of 5 full rounds commence 5 minutes full lung resonant frequency breathing.

Cold exposure protocol for weight loss – fat loss optimisation protocol – By Andrew Huberman

This is a specific CWI protocol for weight loss. Based on exploitation of the body's shiver response. Shivering increases brown fat metabolism and stimulates succinate release which is the trigger to increase brown fat metabolism and increase the process that converts white and beige fat to brown fat. As brown fat is more readily available to use as a thermogenic energy source, white fat loss can be generated by increased stimulation of the pathway that converts white fat (which is not efficiently metabolised as energy) to brown fat.

From a weight loss perspective, the more readily white fat is converted to brown fat the more readily we can lose weight (fat). However, for this protocol to work the participant must allow themselves to shiver. Resisting the shiver will circumvent the brown fat burning pathway.

The process.

- Get in the ice at a temperature that induces you to shiver
- Get in the cold water until shiver starts.
- Then get out of the cold water and stand in scare crow pose allowing yourself to shiver 1 -3 minutes.
- Then get back in cold water 1 minute
- Repeat x 3 rounds.

Once you become cold adapted, the thermogenic effect and shiver fat loss mechanism are no longer effective. Due to the body no longer recognising the stress and no longer producing the noradrenaline, normally produced through the shivering process. Which subsequently reduces the thermogenic fat burning process.

The CWI is generally effective for 2 to 3 months before we become accustomed to it. Rotating cold exposure every 2 – 3 months can prevent cold adaptions that effectively override the shiver / brown fat conversion process.

End of the Breath FX Work Shop.