Ventilatie een inspirerend probleem!?

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Programma

Erik Hulzebos

- Ademregulatie in rust en disfunctioneel ademen

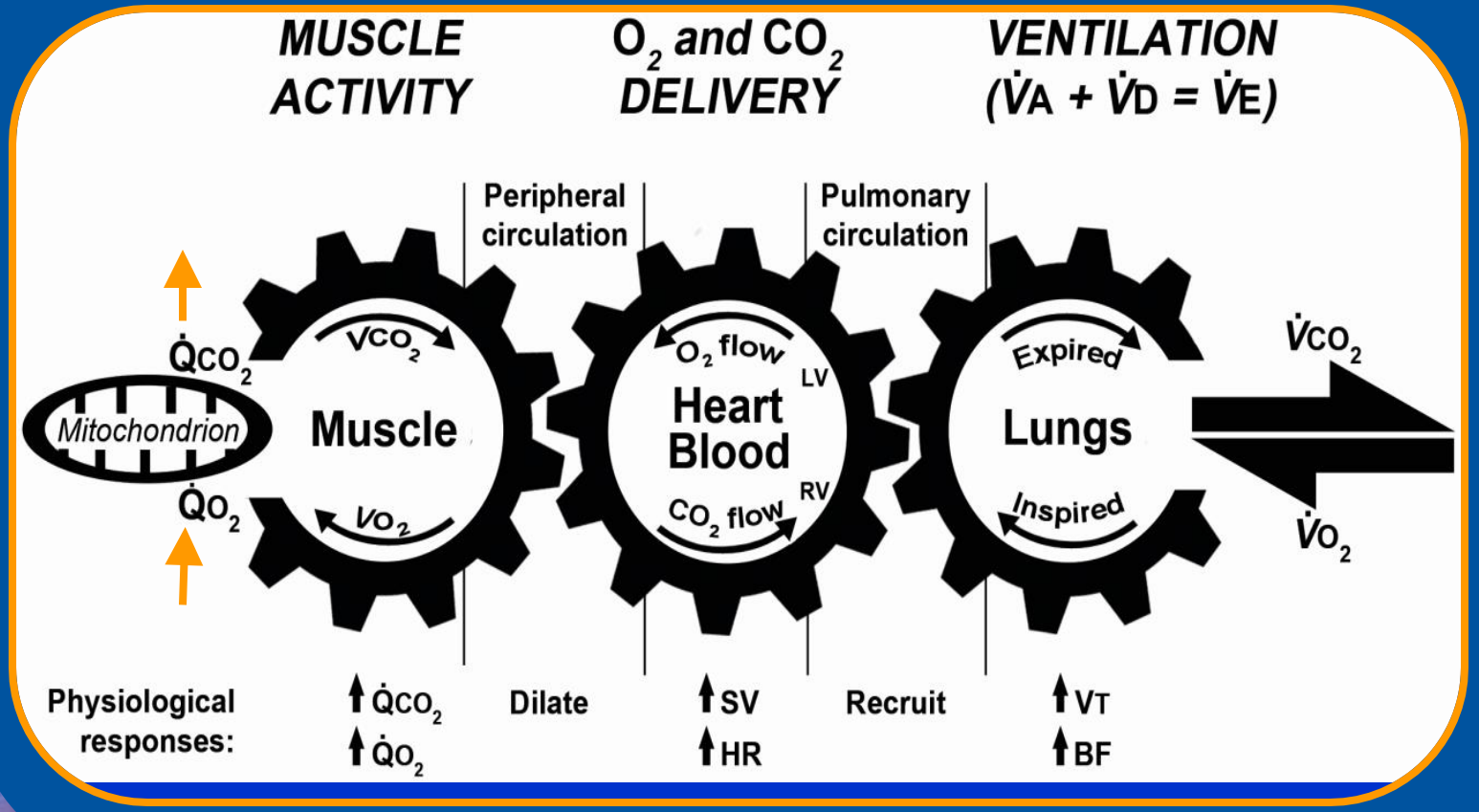
- PAUZE

Wilmer Oosterom

- Praktische handvatten

Fysiologische respons

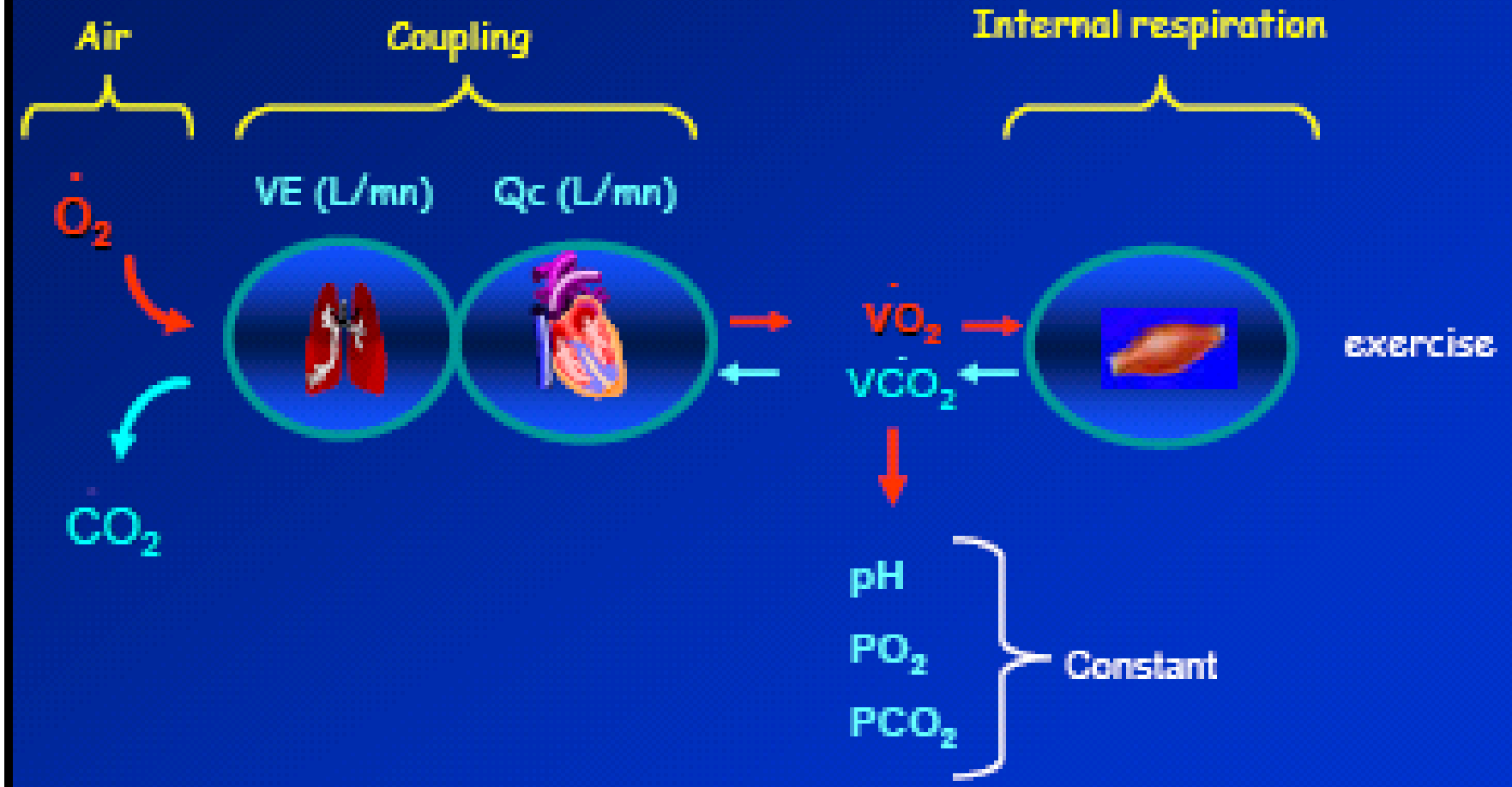
(koppeling cellulaire (interne) respiratie en pulmonale (externe) respiratie)



Principles of Exercise Testing and Interpretation. Wasserman et al., 2005 (9-Panel Plots)
(cardio-respiratory-metabolic homeostasis pathways)

Ventilation: a model of complexity

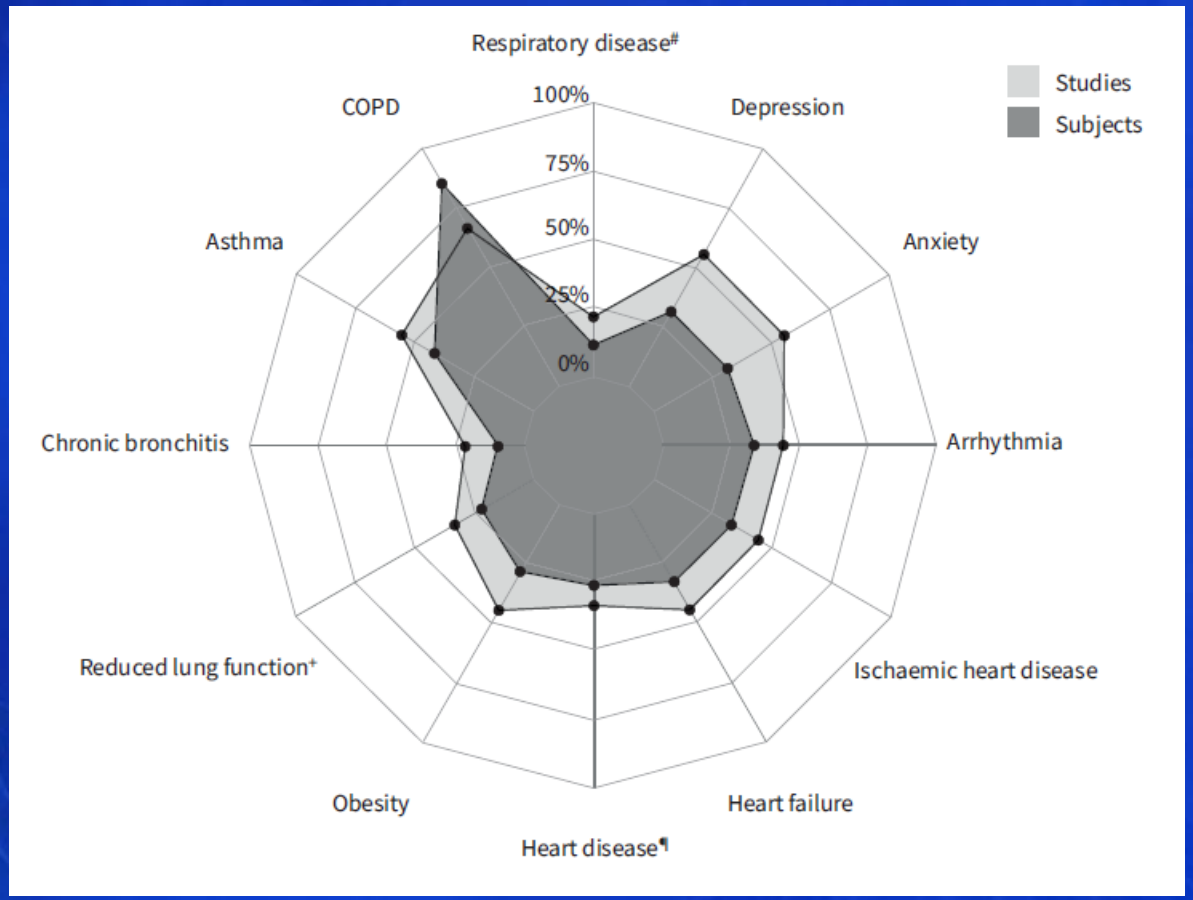
At the beginning everything seems so simple:



Disfunctioneel Ademen (DB)

- DB is een verzamelnaam voor “biomechanische” veranderingen van het adempatroon resulterend in *dyspneu klachten* (Barker and Everard, 2015)
- DB kan zich manifesteren door een lichamelijke en/of psychologische oorzaak en/of door een onderliggende ziekte
- Prevalentie ~ 9% in de algehele populatie
- In astma / COPD populatie is de prevalentie ~ 29% (Thomas et al, 2005).
- Nog geen GOUDEN STANDAARD voor diagnostiek waardoor probleem vaak niet onderkent/herkent wordt door medici.

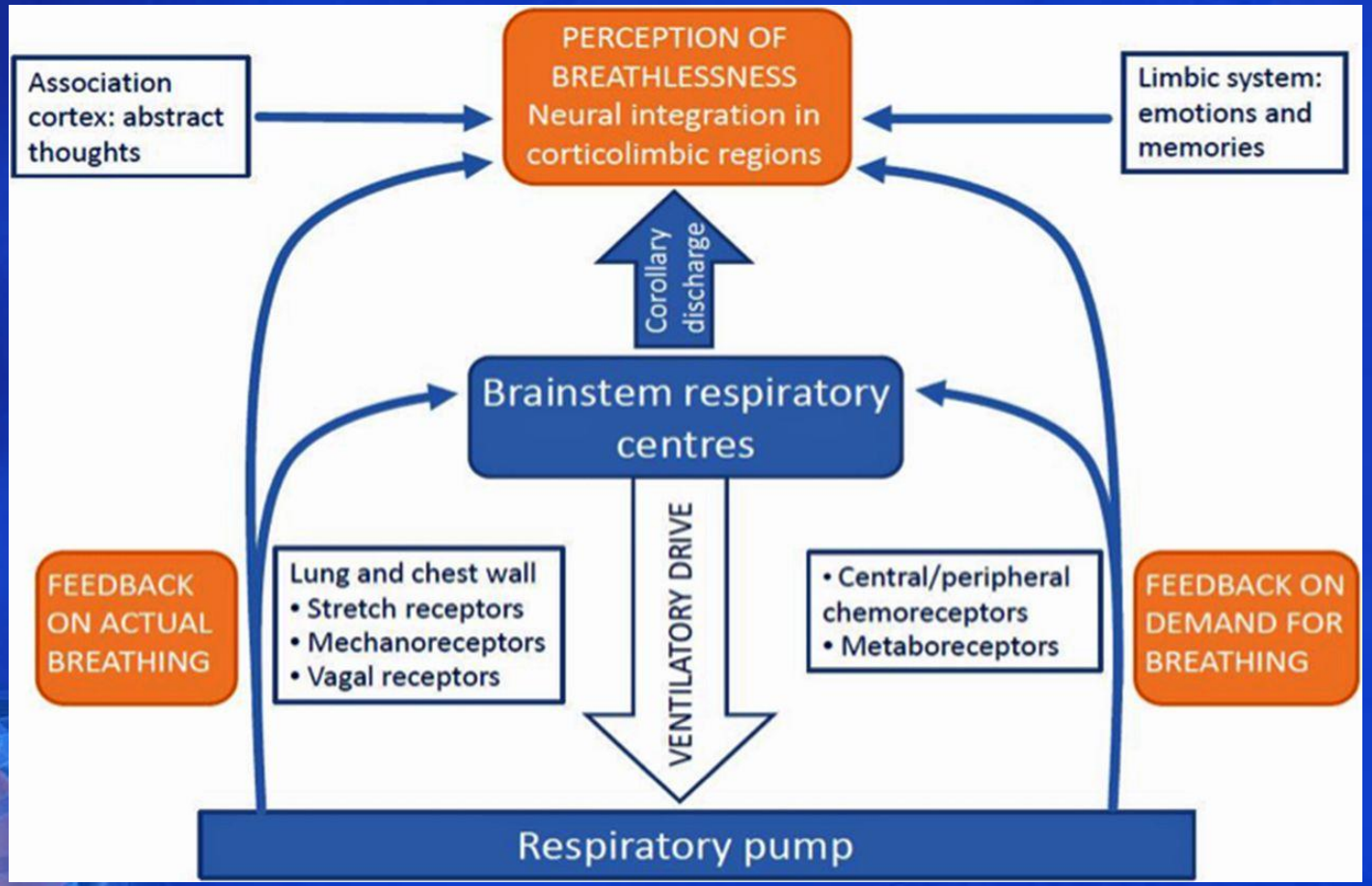
De associatie tussen onderliggende pathologie, depressive, angst en ‘breathlessness’



- ERS Monographs, 2022: Complex Breathlessness

Breathlessness:

Mismatch tussen vraag naar ventilatie en feedback actuele ventilatie



- Pathophysiology of breathlessness (Adapted from Moosavi et al. *2011*)

Ademregulatie (1)

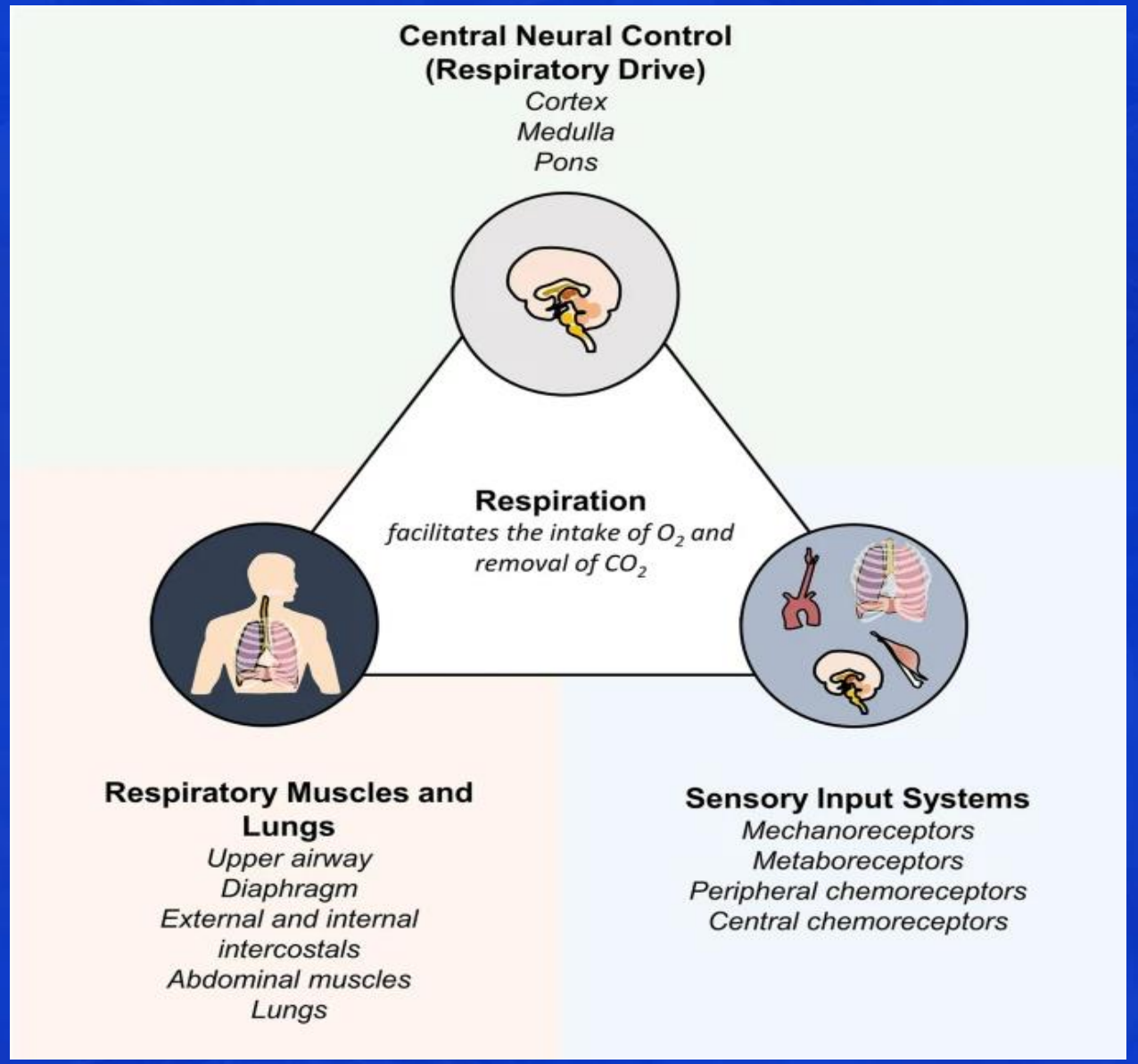
Ademen:

- 5% “bewust” [(Neo) Cortex]
- 95% “onbewust” [Hersenstam & Limbische system]

Fysieke, mentale of emotionele stress:

- Via autonome ZS → (onbewuste) verandering adempatroon, ademfrequentie en ademdiepte
- Acute stress → “Rapid Shallow” adempatroon met geringe bijdrage van het diafragma.

DB kan dus onbewust “aangeleerd” zijn en komt tot uiting in rust en/of bij (fysiologisch/psychologisch) stress!

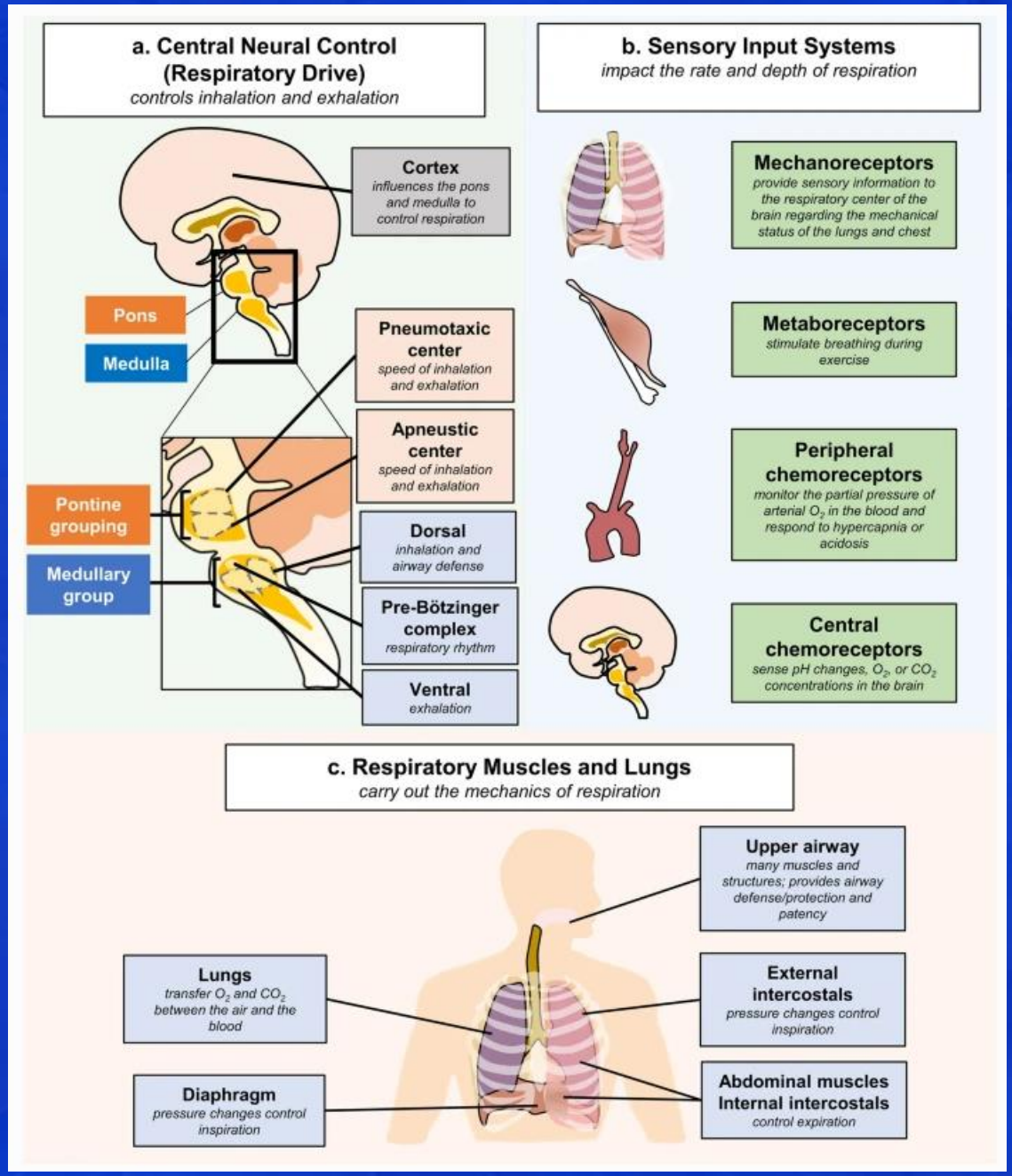


- *Webster, L.R., Karan, S. The Physiology and Maintenance of Respiration: A Narrative Review. Pain Ther 9, 467–486 (2020).*

Ademregulatie (2)

Ademcentrum (Pons en Medulla):
- Ademritme (ademfrequentie)
- Ademdiepte (teugvolume → CO_2)
- Snelheid van in- en uitademen
- In- en uitademen

➢ NB. deze adem onderdelen worden (onbewust) en onafhankelijk van elkaar gereguleerd!



- *Webster, L.R., Karan, S. The Physiology and Maintenance of Respiration: A Narrative Review. Pain Ther 9, 467–486 (2020).*

Ademregulatie (3)

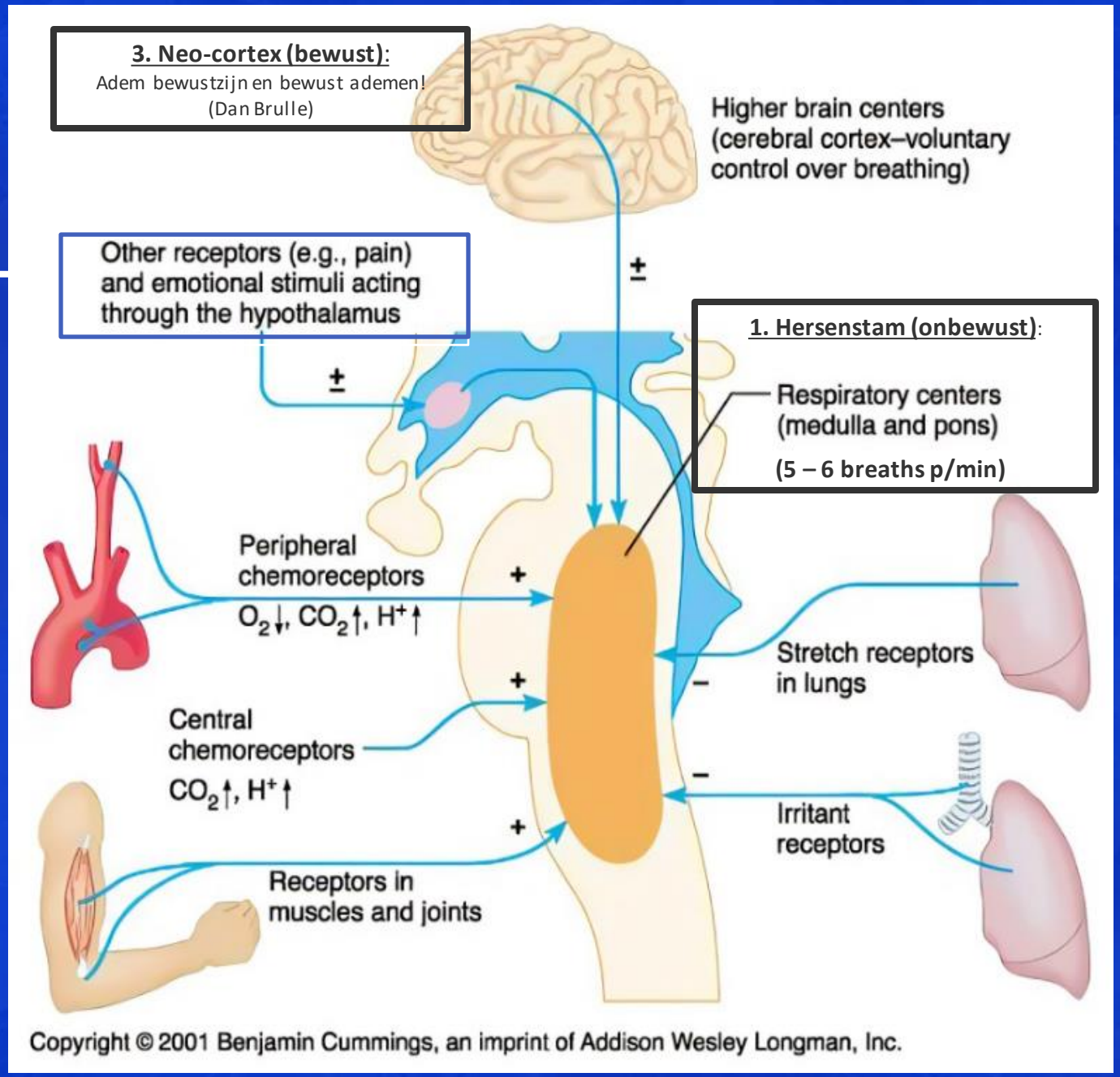
2. Limbische systeem (onbewust):
- (Emotionele) Stress → afvlakking diafragma (hypertoon en relatief immobiel) → costo-sternaal adempatroon c.q. "Rapid Shallow" adempatroon (V_D/V_T ↑; RSBI ↑)

De mentale en emotionele status heeft een grote impact op ademfuncties en ademsymptomen.

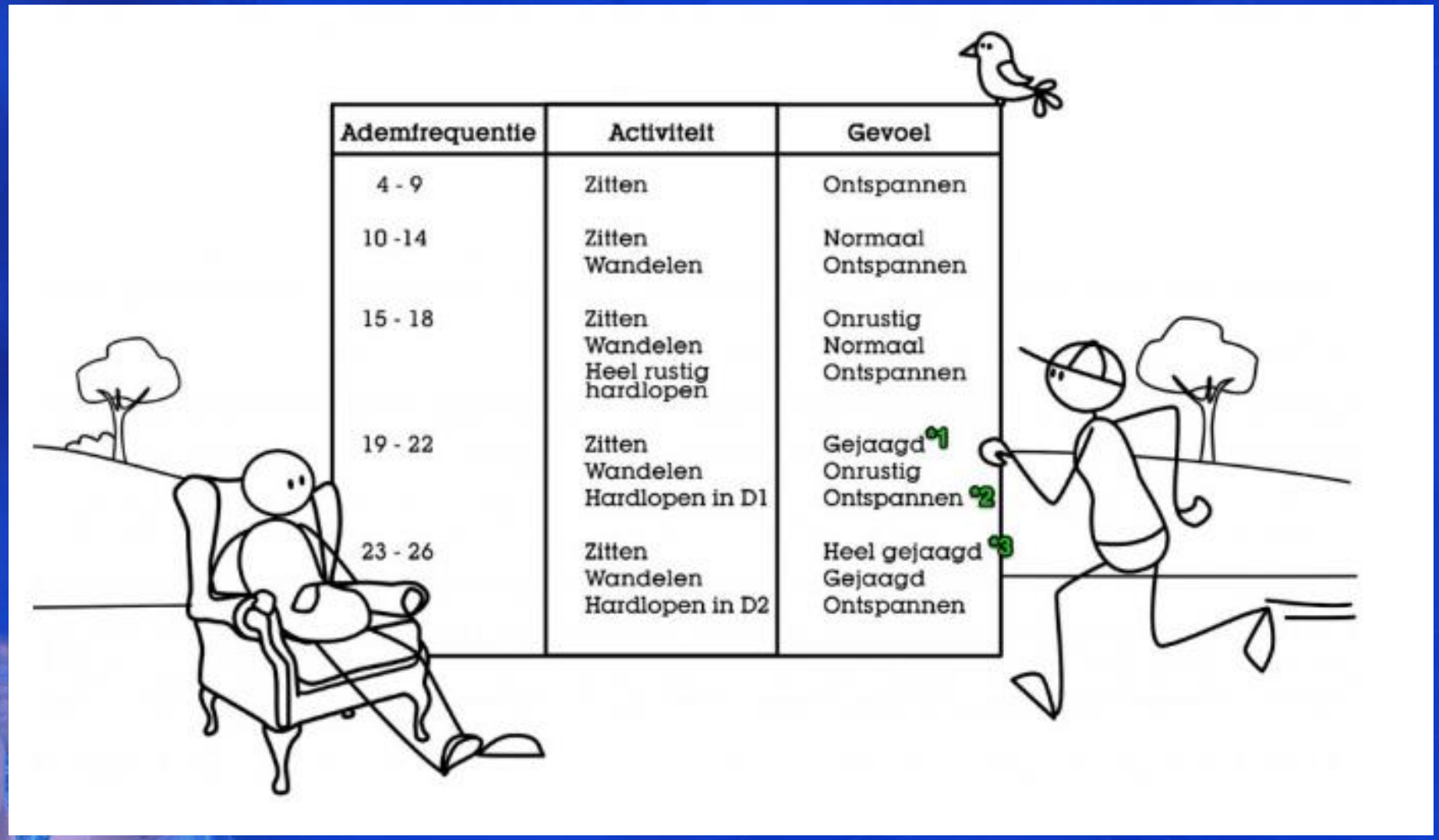
De manier waarop een persoon ademt (bewust en/of onbewust) heeft effect op de functie van het brein en zenuwstelsel en op de mentale en emotionele status.

➢ Ademen = Schakel tussen het (bewuste) centrale en (onbewuste) perifere (autonome) zenuwstelsel!

+= Gaspedaal (sympaticus ↑)
- = Rempedaal (parasympaticus ↑)



Relatie ademfrequentie, activiteit en gevoel



Ademfrequentie	Activiteit	Gevoel
4 - 9	Zitten	Ontspannen
10 -14	Zitten Wandelen	Normaal Ontspannen
15 - 18	Zitten Wandelen Heel rustig hardlopen	Onrustig Normaal Ontspannen
19 - 22	Zitten Wandelen Hardlopen in D1	Gejaagd *1 Onrustig Ontspannen *2
23 - 26	Zitten Wandelen Hardlopen in D2	Heel gejaagd *3 Gejaagd Ontspannen

- *Bron: Koen de Jong. Sportrusten.nl*

Parasympatisch ↑:

- Uitademen (langzaam)
- Neus (diafragmaal)
- Ademfrequentie ≤ 6 BPM
- Adempatroon: Low, Slow, Deep (diafragmaal)

Sympatisch ↑:

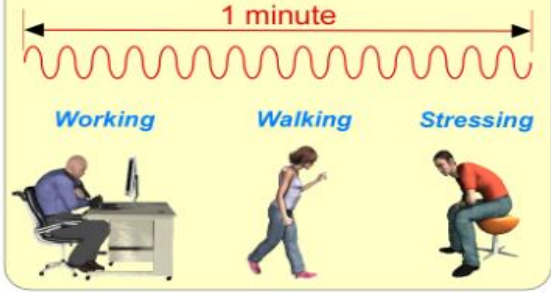
- Inademen (snel)
- Mond (costo-sternaal)
- Ademfrequentie > 6 BPM
- Adempatroon: "Rapid Shallow" (costo-sternaal)

How Breathing Rate Affects Overall Health

The average person breathes 12-18 breathes per minute (BPM) during regular activity of standing, sitting & walking, engaging the sympathetic nervous system (SNS). Constant duration in the SNS dumps neurotransmitters of cortisol and norepinephrine into the blood stream putting the vital organs in a state of constant high alert and stress. Health and fitness experts suggest that 6 BPM is optimal for the lungs to properly oxygenate the whole body, balance the blood chemistry and also remove toxins. The lungs are responsible for removing 70% of the body's waste by-products through exhalation. This is more easily accomplished through mindful breathing patterns from exercises such as mediation, qigong, tai chi and yoga.

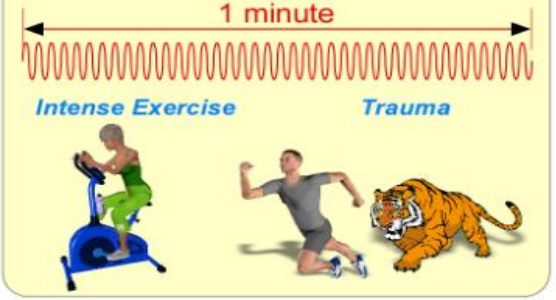
Parasympathetic Nervous System Activates at 10 BPM or slower.

Average BPM during sitting, standing, minimal activity, 12-18 BPM



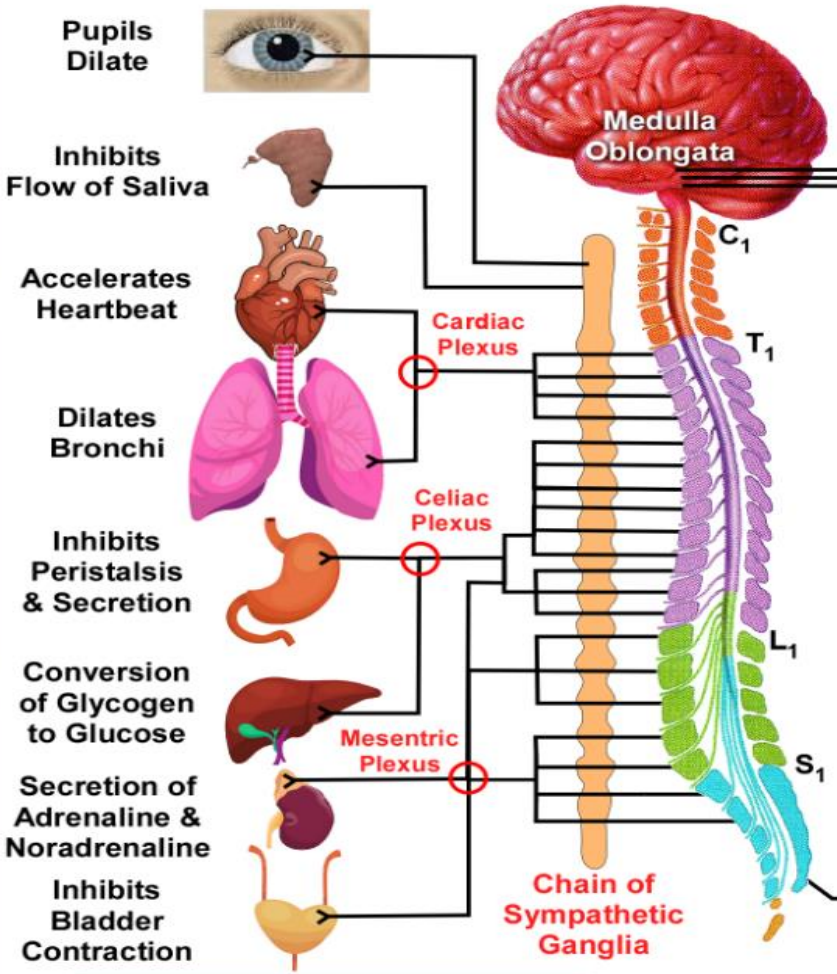
Average BPM during sauna or moderate swimming activity, 20-30 BPM

Average BPM during intense exercise/intense trauma, 40-60 BPM



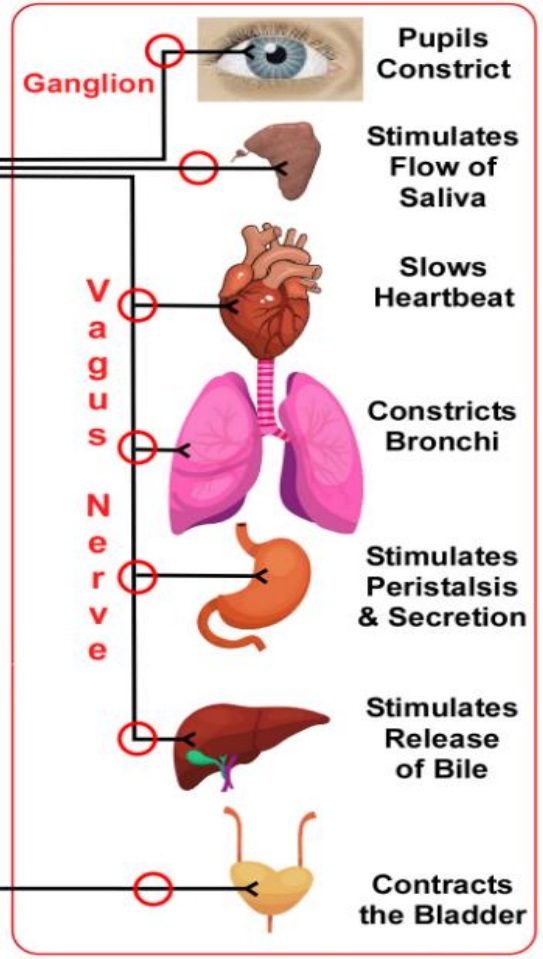
www.MindandBodyExercises.com

Sympathetic Nervous System
"Fight or Flight"



Neurotransmitters secreted in SNS: (stress hormones) Cortisol, Norepinephrine

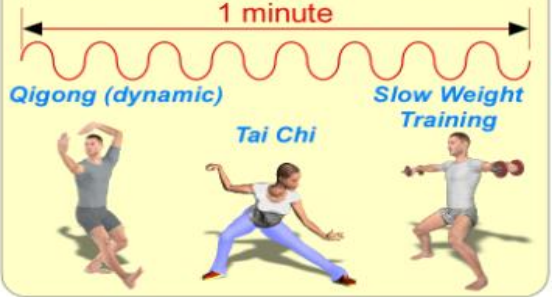
Parasympathetic Nervous System
"Rest & Digest"



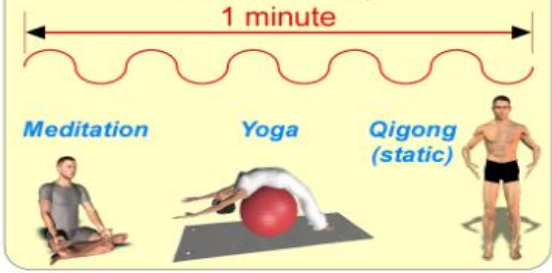
Neurotransmitters secreted in PNS: ("happy" hormones) Dopamine, Oxytocin, Seratonin, Endorphins

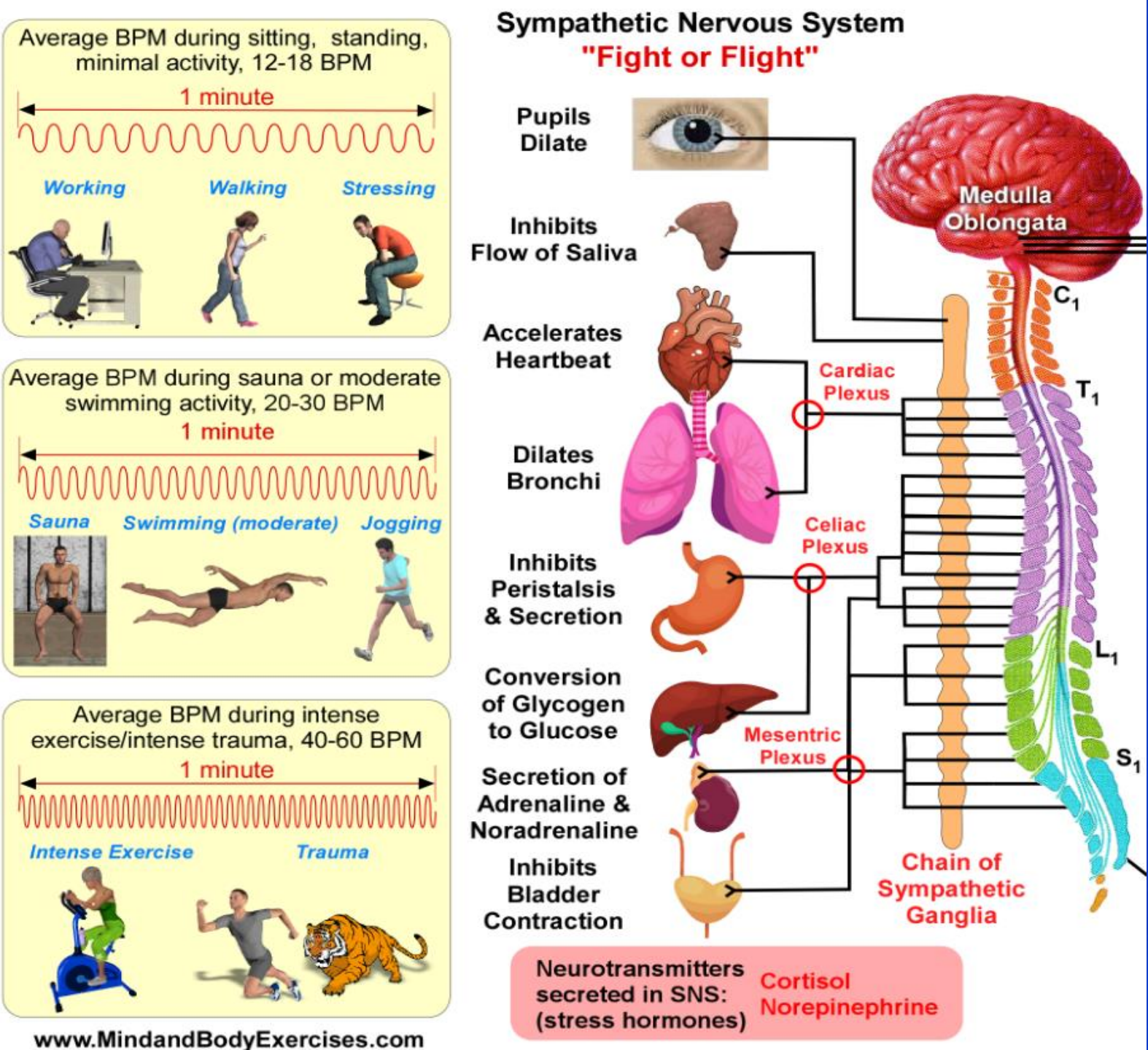
Regulated Breaths at 10 BPM.
(3 second inhale, 3 second exhale)

Regulated Breaths at 7.5 BPM.
(4 second inhale, 4 second exhale)



Regulated Breaths at 5 BPM or less.
(4 second inhale, 4 second pause, 4 second exhale)



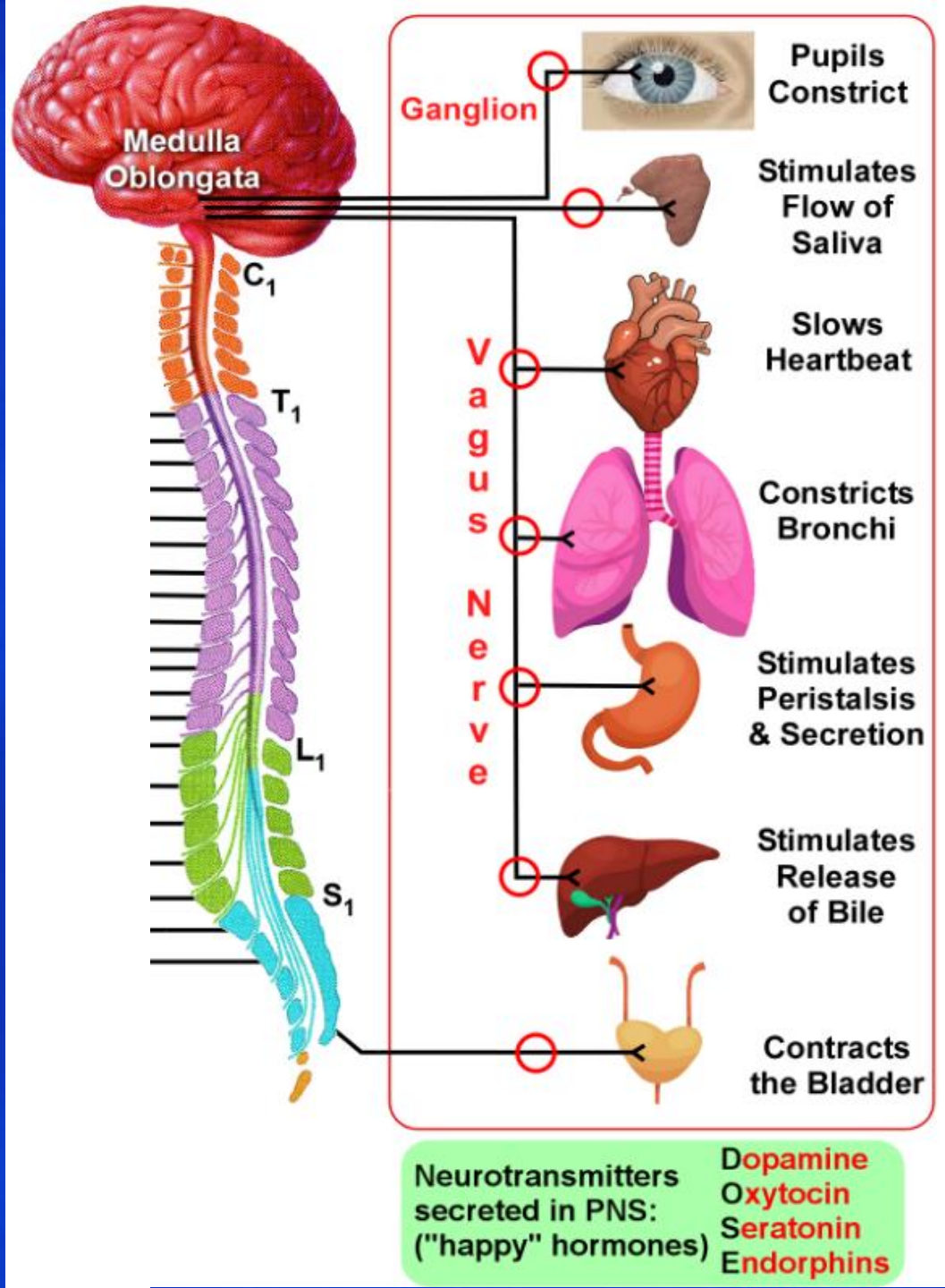


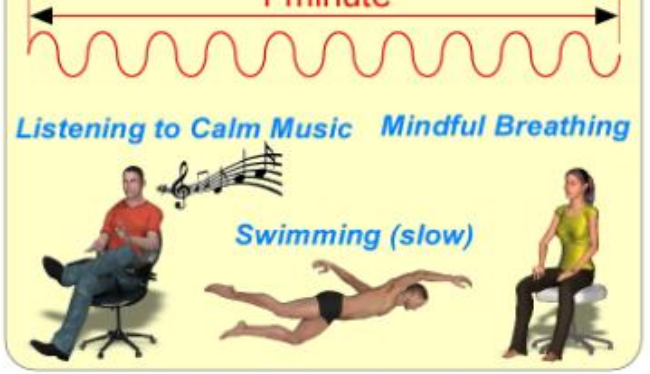
Sympatische Zenuwstelsel:

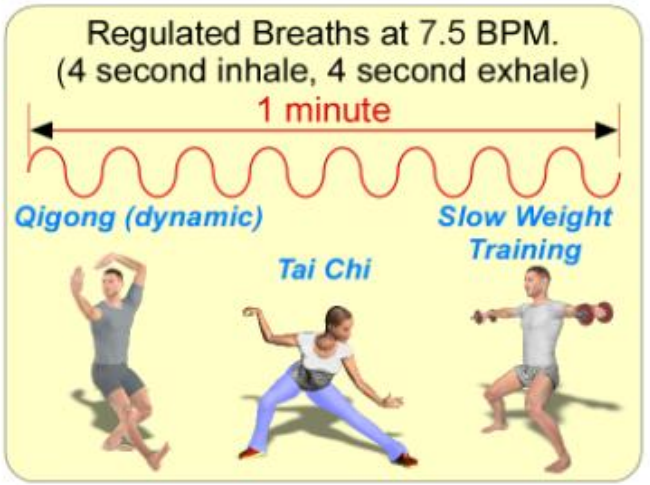
- Fight
- Flight
- Freeze

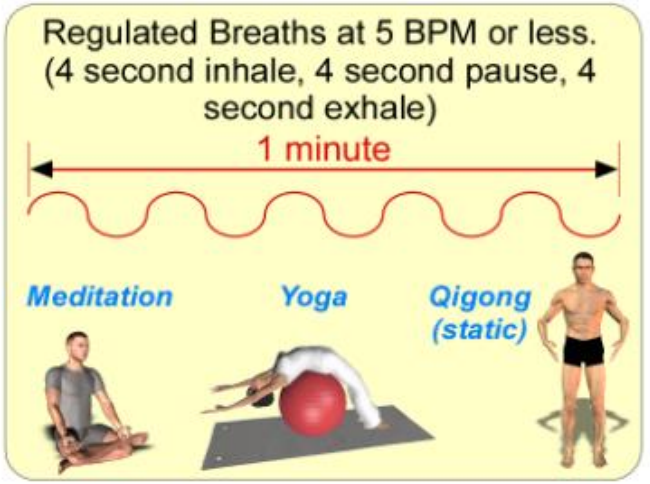
Parasympatische ZS:

- Rest
- Digest
- Recovery (herstel)

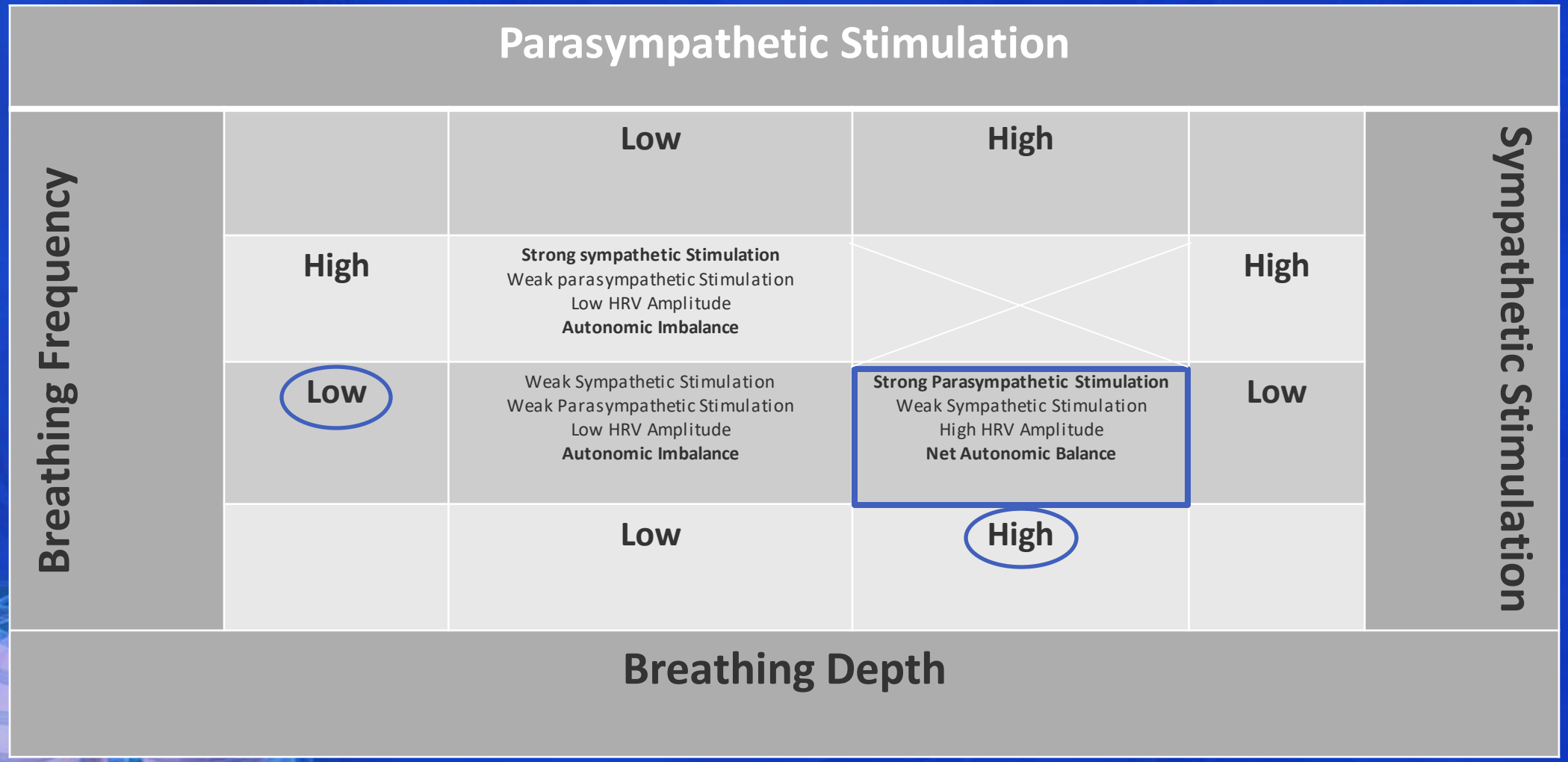






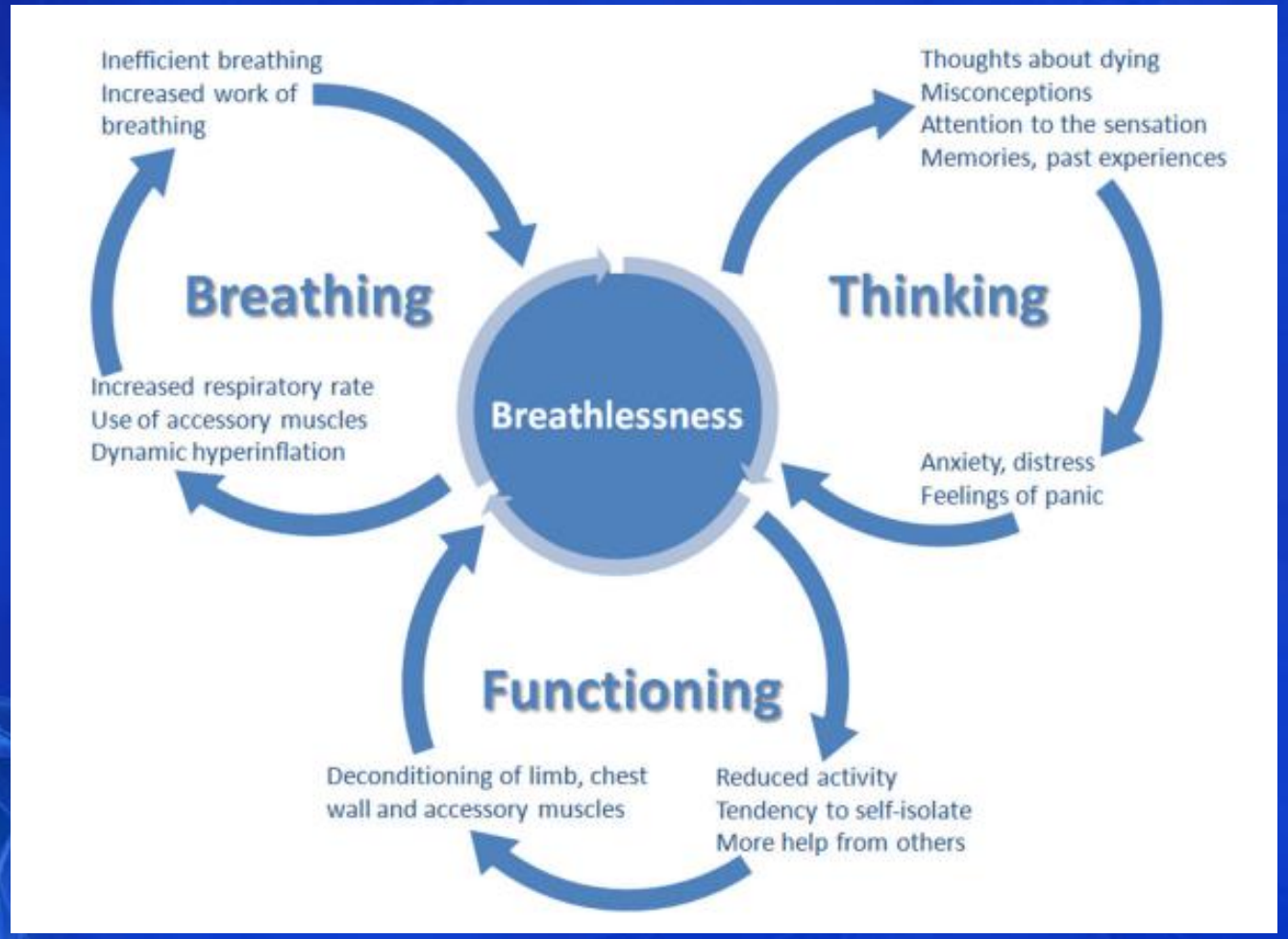


Relatie ademfrequentie, ademdiepte en AZS



- *The New Science of Breath. Stephan B Elliott (ISBN10: 0978639901)*

The Breathing, Thinking, Functioning Clinical Model

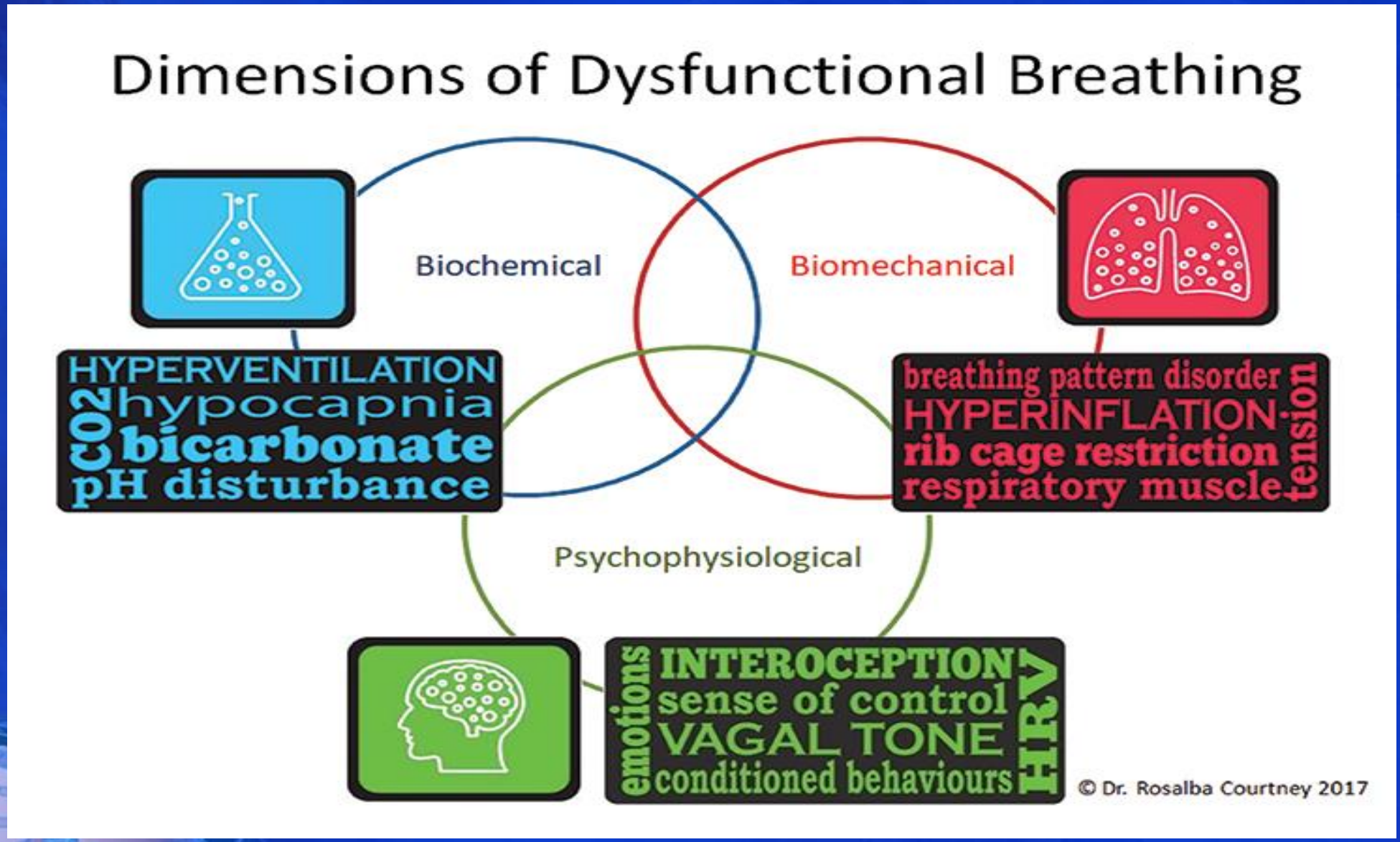


- Primary Care Respiratory Medicine (2017) 27:27 ; doi:10.1038/s41533-017-0024-z

Behandelopties volgens het BTF-model

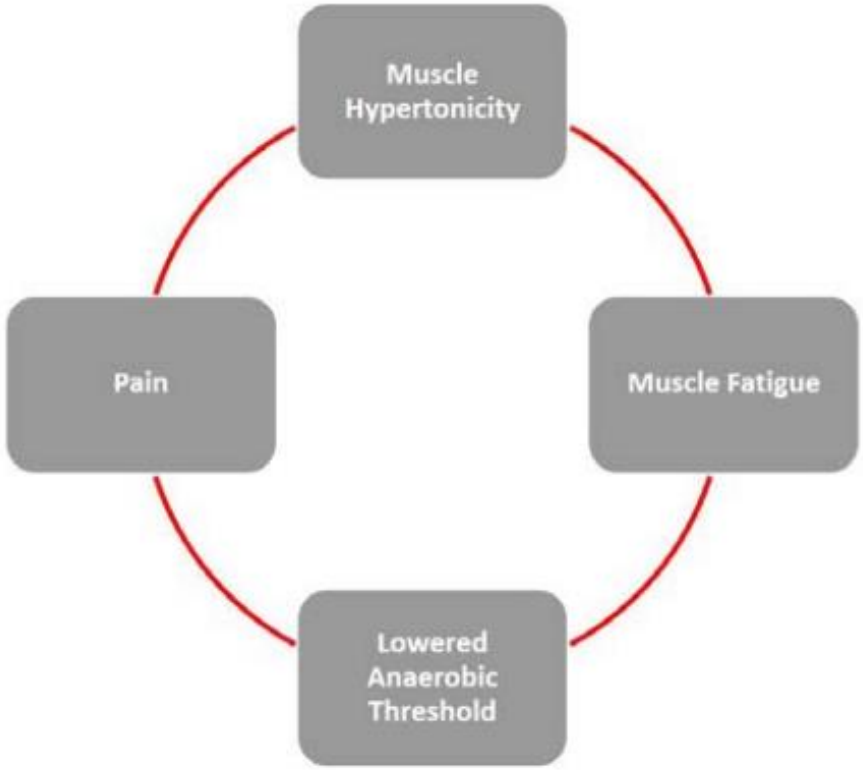
Breathing	Thinking	Functioning
Breathing techniques	Cognitive behavioural therapy	Pulmonary rehabilitation
Handheld fan	Relaxation techniques	Activity promotion
Airway clearance techniques	Mindfulness	Walking aids
Inspiratory muscle training	Acupuncture	Pacing
Chest wall vibration		Neuromuscular electrical stimulation
Non-invasive ventilation		

Screening & Beoordelen Ademen
(Multidimensionaal perspectief)

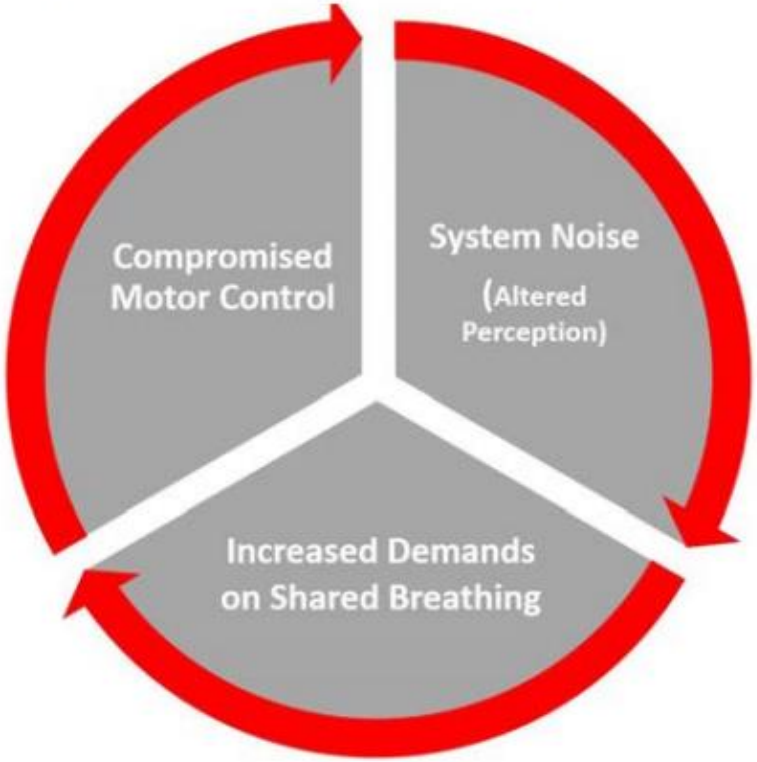


NB. De psychofysiologische dimensie beïnvloed de ventilatoire drive, ademcontrole en adempatroon en kan een disfunctie in het biochemische en/of biomechanische dimensie in stand houden.

Effects of Hyperventilation:



Effects of Dysfunctional Breathing & Motor Control



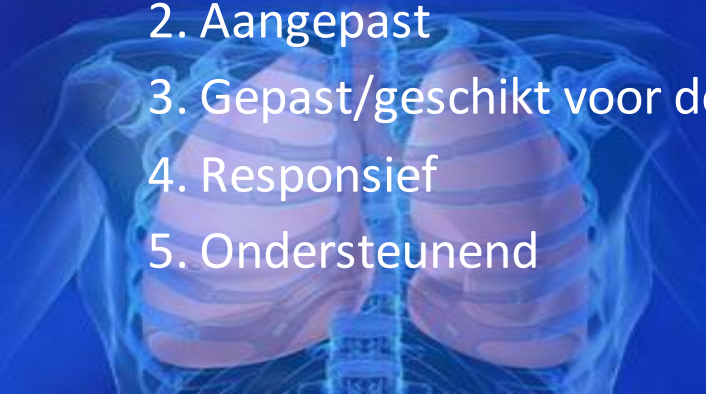
Functioneel vs disfunctioneel ademen

Disfunctioneel ademen:

- Hyperventilatie (low CO_2)
- Mond ademen
- Sterno-costaal (borst) adempatroon
- Geen bevredigende diepe ademteug kunnen nemen
- Onverklaarbare discomfort bij het ademen
- Combinatie van bovengenoemde factoren

Functioneel ademen heeft de volgende eigenschappen:

1. Efficiënt
2. Aangepast
3. Gepast/geschikt voor de activiteit
4. Responsief
5. Ondersteunend



Functies van Ademen

PRIMAIRE FUNCTIES VAN ADEMEN:

1. Biomechanisch
    a. Actie neuromusculaire respiratoire pomp
    b. Verandering in de intra-abdominale en intra-thoracale druk (beweging van lucht, lymfe en bloed)
2. Biochemisch
    a. Effecten op bloedgassen en biochemie

SECONDAIRE FUNCTIES VAN ADEMEN:

- (Zelf) regulatie van mentale en emotionele status
- Praten en stem geluid
- Homeostatische ritmes en oscillaties
- Stabiliteit WK, houding en “motor control”

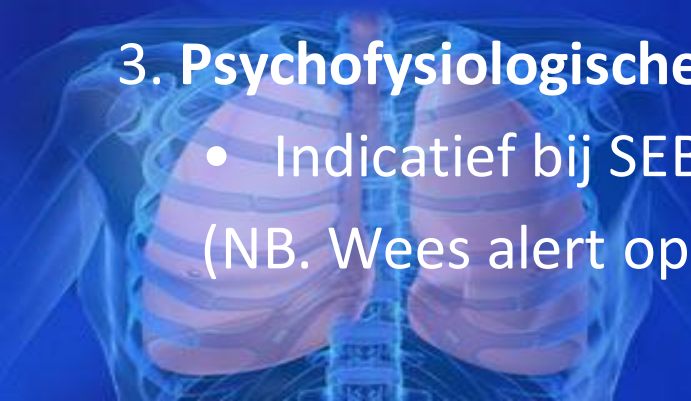
Beoordeling Ademen

1. **Biochemische Beoordeling**
   a. Testing (o.a. PaO_2 ($PETO_2$); $PaCO_2$ ($PETCO_2$); pH; Bicorbonaat; Base Excess)
   b. Breath Hold Time (BHT)

2. **Biomechanische Beoordeling**
   a. Hi-Lo Assessment
   b. MARM Assessment
   c. BPAT Assessment

3. **Psychofysiologische Beoordeling**
   - Indicatief bij SEBQ > 11 pnt en/of NQ > 22 pnt.

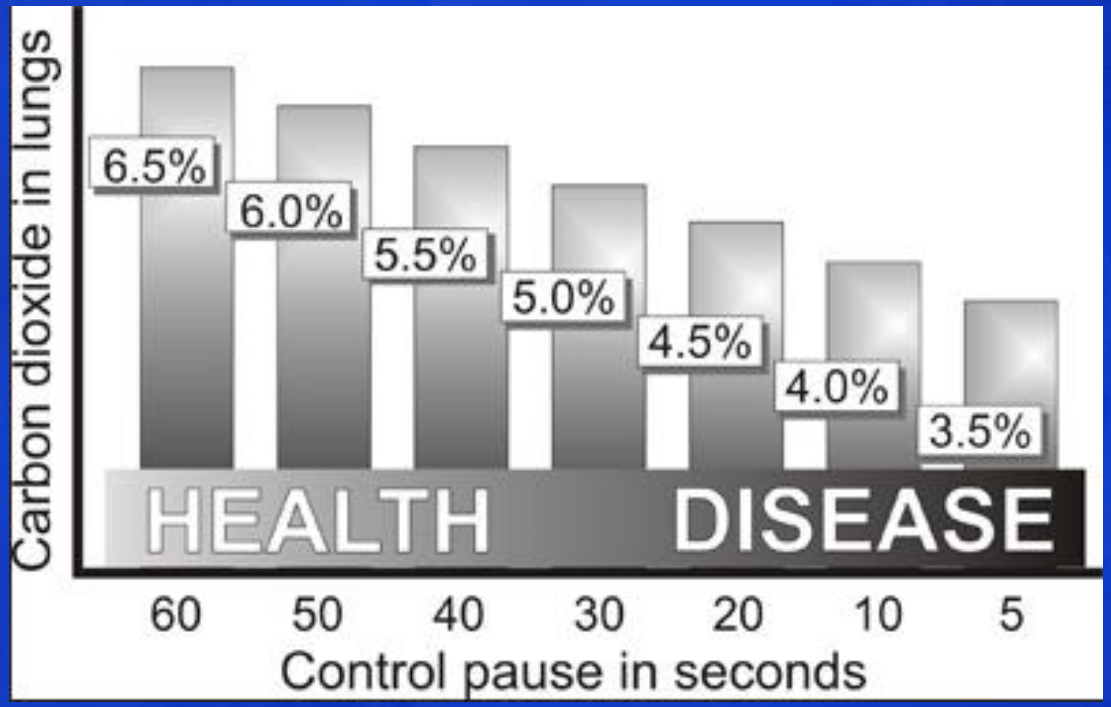
   (NB. Wees alert op de vragen t.a.v. stress, spanningen en angst!)



BOLT-score, Controle Pauze, Breath Hold Time

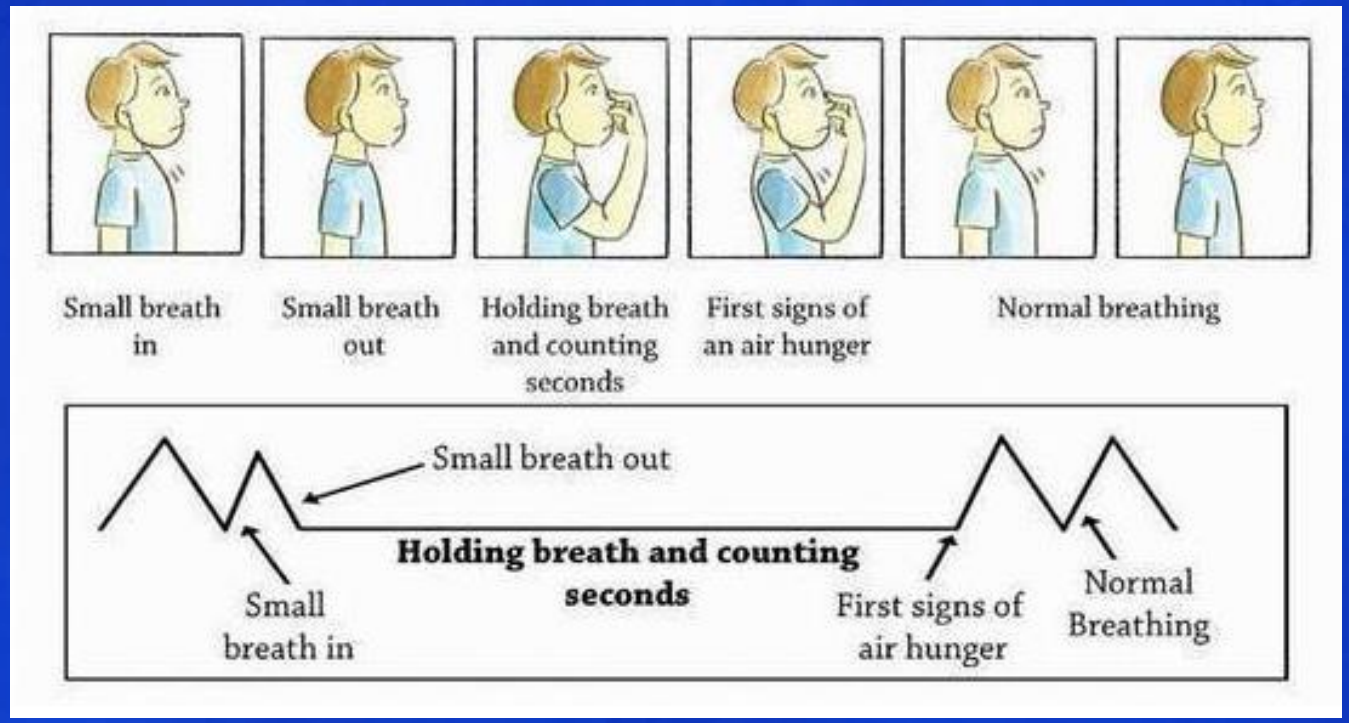
(voorspeller mate van kortademigheid tijdens sport en inspanning)

- De BOLT is geïntroduceerd door Patrick McKeown, bekend van The Oxygen Advantage (dr. Buteyko)
- BOLT staat voor Body Oxygen Level Test en is een snelle en gemakkelijke manier om te testen hoe jouw CO_2-(in)tolerantie is
- BHT = adempauze (CP) na een normale expiratie tot de eerste onwillekeurige contractie ademspier(en).



Uitvoering BOLT-score

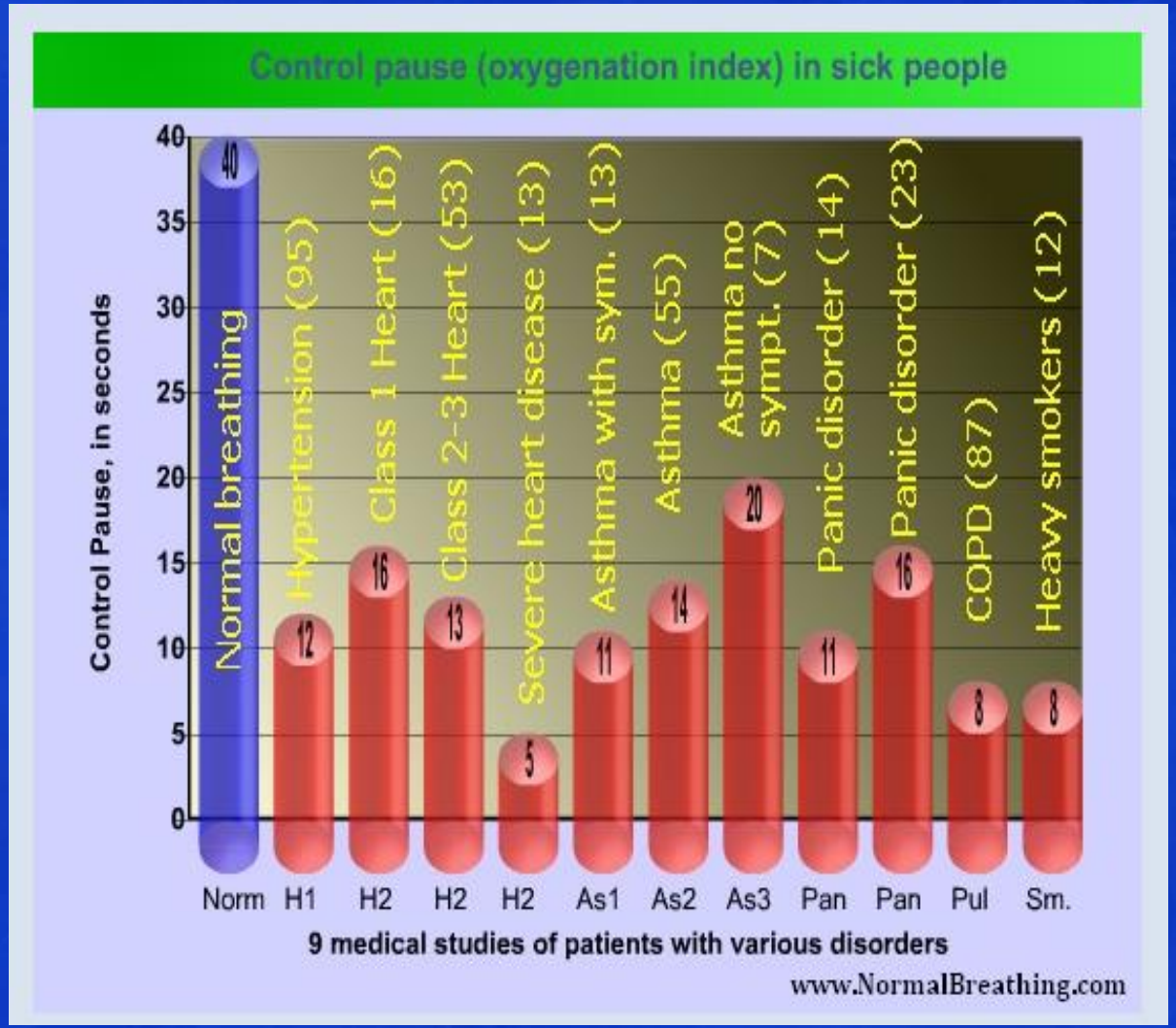
- Om juist te meten is het aan te raden om 10-minuten te “rusten” voor je de test doet
- En heb een timer bij de hand



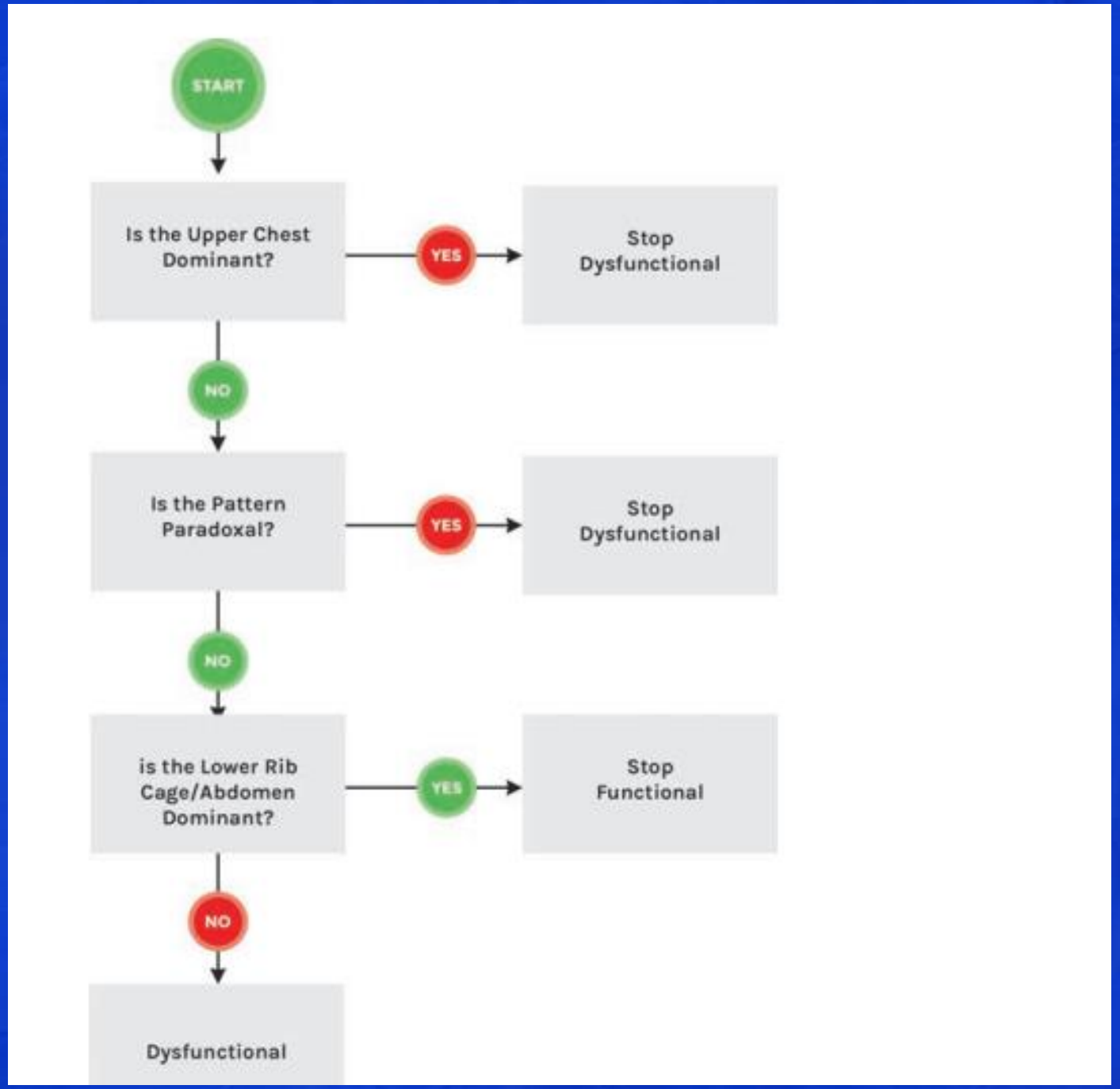
Interpretatie BOLT-scores

- < 10 sec: your health is severely affected
- 10 – 20 sec: you are probably suffering from a chronic illness, along with symptoms, such as: blocked nose, snoring, insomnia, coughing, short breath, asthma
- 21 – 40 sec: most symptoms are not there, but may occur following a triggering event
- > 40 sec: good health

(to ensure a permanent physiological change, it is necessary to attain a morning CP of 40-seconds for 6 months)



De Hi-Lo Breathing Assessment



Manual Assessment Respiratory Motion (MARM)

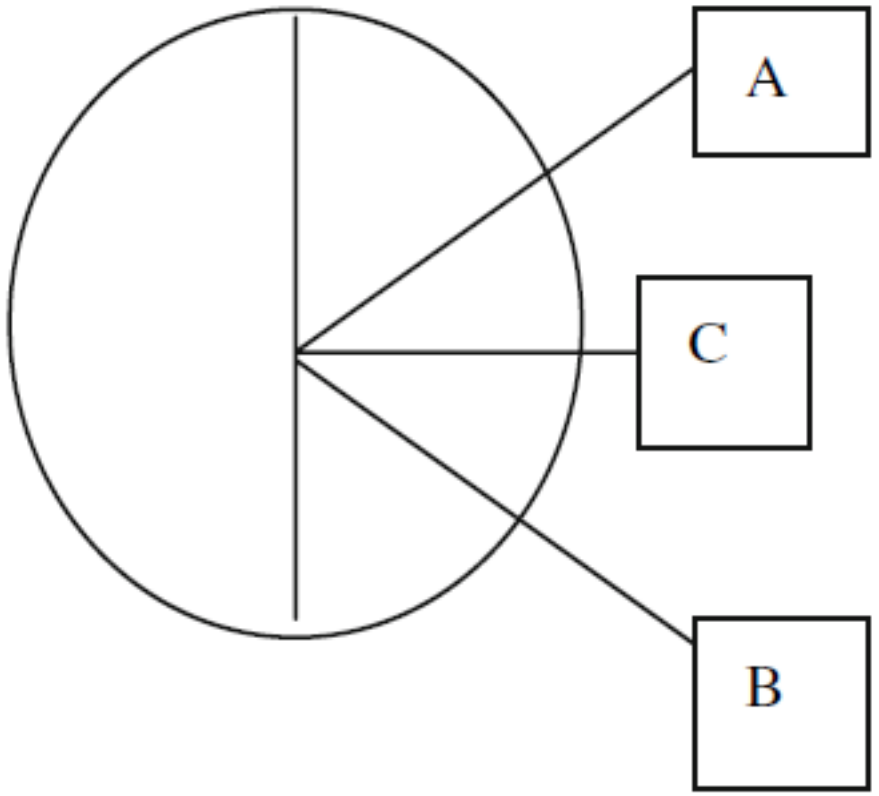


Fig. 1 The MARM graphic notation

Hand Position

Calculating MARM Variables

- Area = Angle AB
- Average= A+B/2
- Balance= Angle AC (minus) Angle AB
- % Rib Cage=AC/ABx100

- *Appl Psychophysiol Biofeedback (2008) 33:91–100*

Brompton Breathing Pattern Assessment Tool (BPAT)

- 5-minuten voor de beoordeling rustig zitten op een stoel,
- Tel ademfrequentie en observeer adempatroon gedurende 1-minuut,
- Scoor vervolgens onderstaande tabel.

	0	1	2
Abdominal or upper chest movement: Where is movement occurring in tidal volume breathing at rest?	**Abdominal** (Diaphragm level and below)	**Combination** (Movement in both upper chest and abdomen)	**Apical** (Upper chest rises and falls with each breath)
Inspiratory flow Do they have increased inspiratory flow? This would be indicated by an audible breath IN through either nose or mouth and includes any type of wheeze.	**Silent**	**Audible**	**Loud**
Expiratory flow Do they have increased expiratory flow? This would be indicated by an audible breath OUT through either nose or mouth and includes any type of wheeze.	**Silent**	**Audible**	**Loud**
Channel of inspiration and expiration Are they breathing through their; nose, mouth or a combination of both during the minute assessed?	**Nose** (with their mouth closed throughout the minute assessed)	**Nose and mouth** (During the minute some breaths are through their nose and some through their	**Mouth** (Breathing with mouth open throughout)

Air hunger During the minute assessed is the patient showing signs of air hunger. This includes yawning, sighing or taking a deeper breath than their tidal breaths?	**None**	**Once per minute**	**Twice or more times per minute**
Respiratory Rate What is their respiratory rate in the minute assessed? **TOTAL RR_____**	**12 or less**	**13-25**	**25+**
Rhythm Are their breaths evenly spaced throughout the minute? Do they appear regular and rhythmical?	**Rhythmical**		**Erratic**
Scoring	0	1	2
Score for each column			
		TOTAL SCORE	

Score ≥ 4, indicative of breathing pattern irregularities with a sensitivity of 92%.

- *Todd, et al. Novel assessment tool to detect breathing pattern disorder in patients with refractory asthma. Respirology 2018;23:284–90.*

Ervaren klachten?

- Nijmeegse Vragenlijst: subjectieve score van “functionele ademklachten”
- Nijmeegse Vragenlijst: sensitiviteit= 91% en specificiteit= 95%
  - Score >23 is ‘cut-off value’ voor hyperventilatie
  - Score ≥19 differentieert (inspanningsgebonden) hyperventilatie patiënten van “normale” personen

Hyperventilatie
Nijmeegse Vragenlijst

Instructie:
Kruis voor elke vraag aan of u deze klachten nooit, zelden, soms, vaak of zeer vaak hebt of hebt gehad.

		Nooit	Zelden	Soms	Vaak	Heel vaak
1	Pijnlijke steken in de borst					
2	Gespannenheid					
3	Een waas voor de ogen					
4	Duizeligheid					
5	In de war zijn, of het gevoel hebben het normale contact met de omgeving te verliezen					
6	Een snellere of diepere ademhaling					
7	Ademnood					
8	Benauwd voelen in of rond de borst					
9	Opgeblazen gevoel in de buik					
10	Tintelingen in de vingers					
11	Niet voldoende diep kunnen doorademen					
12	Stijfheid van vingers of armen					
13	Stijfheid rond de mond					
14	Koude handen of voeten					
15	Bonzen van het hart					
16	Angstig gevoel					
	Subtotalen					
	Totaal					

Waardering:

Nooit	=	0 punten
Zelden	=	1 punt
Soms	=	2 punten
Vaak	=	3 punten
Heel vaak	=	4 punten

Score:
18 punten of meer: hyperventilatie is mogelijk, hoe hoger de score, hoe waarschijnlijker de diagnose
Vanaf 23 punten: hyperventilatie is voor 80 % zeker

- *van Dixhoorn and Folgering, 2015; ERJ Open Res 2015; 1: 00001–2015 | DOI: 10.1183/23120541.00001-2015*

Scoring the SEBQ:

(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				

Scoring the SEBQ

To Score the SEBQ just add the numbers Individuals with scores >= 20 on the Nijmegen on average score >=11 on the SEBQ.

- *Courtney, R. and K.M. Greenwood, Preliminary Investigation of a measure of dysfunctional breathing symptoms: the Self Evaluation of Breathing Questionnaire (SEBQ). International Journal of Osteopathic Medicine, 2009. 12: p. 121-127*

Indicatie(s) ademtherapie en/of ademspiertraining

- Patiënten met een hoge score op de Nijmeegse Vragenlijst (> 22pnt) en/of afwijkend adempatroon (BPAT > 4 pnt) en/of lage BOLT-score (< 25 sec) hebben baat bij ademtherapie.

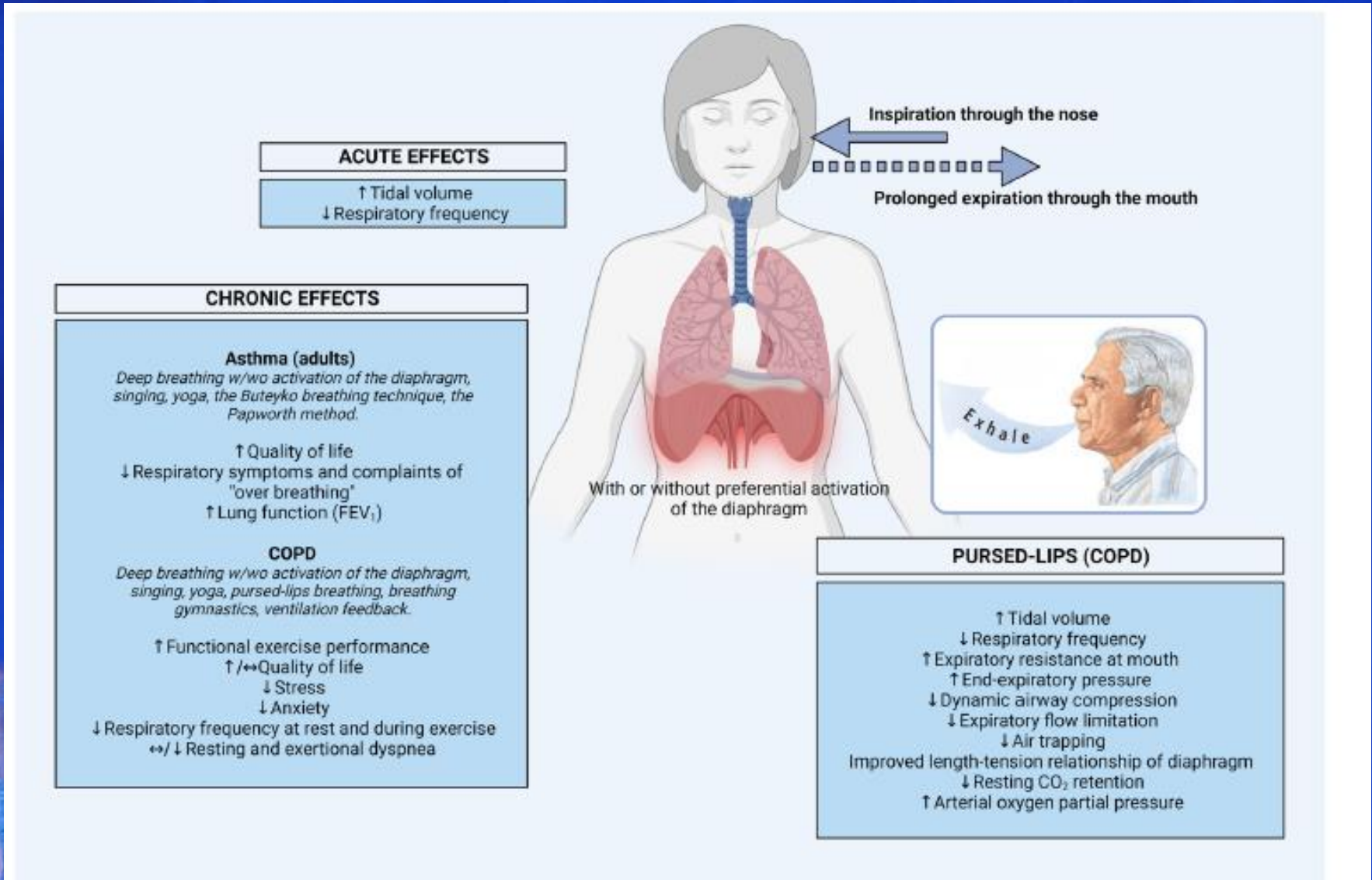
- (Indicatie) ademspiertraining:
  - Verminderde ademspierkracht (zie tabel S4)
  - Symptomen van dyspnoe, hypercapnie, Inspanningsintolerantie

Table S4. Absolute maximal inspiratory pressure (PImax) values obtained at residual volume associated with "higher" likelihood of inspiratory muscle weakness, by sex and age

Age (yrs)	PImax (cmH_2O)	
	Men*	Women+
< 40	63	58
40-60	55	50
61-80	47	43
> 80	42	38

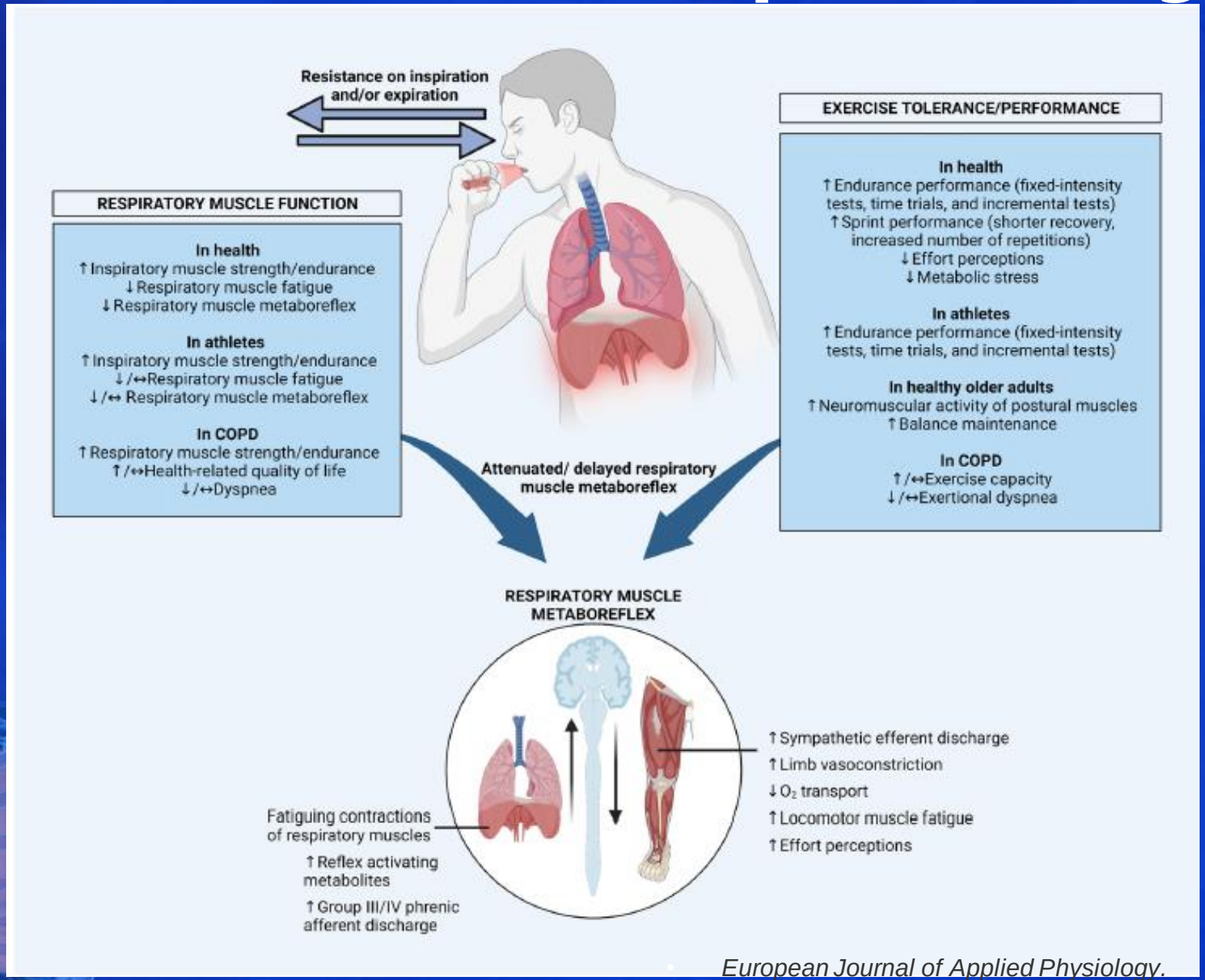
* n = 164 (< 40 y), 302 (40-60 y), 365 (61-80 y), and 35 (> 80 y). + n = 140 (< 40 y), 293 (40-60 y), 387 (61-80 y), and 43 (> 80 y). From Rodrigues et al. [22]

Effecten van ademtherapie



- *European Journal of Applied Physiology. https://doi.org/10.1007/s00421-023-05166-8*

Effecten van ademspiertraining



European Journal of Applied Physiology.

Breathing Pattern Disorder (BPD) / Dysfunctional Breathing

WHAT IS BPD / DYSFUNCTIONAL BREATHING?

A GROUP OF DISORDERS WHERE THERE ARE CHRONIC CHANGES IN BREATHING PATTERN

RESULTING IN:

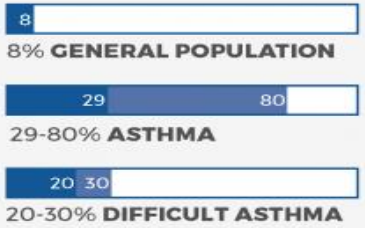
- Dyspnoea
- Chest tightness
- Chest pain
- Deep sighing
- Exercise-induced dyspnoea
- Frequent yawning
- Hyperventilation

HOW DOES IT RELATE TO ASTHMA?

SYMPTOMS ARE OFTEN SIMILAR:

- Under-recognised in asthma population
- Causes symptoms disproportionate to lung disease severity

PREVALENCE:



DIAGNOSIS & ASSESSMENT:

- Nijmegen questionnaire
- Clinical observation
- Oximetry
- End tidal CO2
- Breath hold test (<30s)
- Ventilatory response
- Arterial blood gas
- Plethysmography

TREATMENT OPTIONS:

NOTE: BPD DOES NOT RESPOND TO ASTHMA TREATMENTS

- Breathing retraining by a qualified professional (e.g. physiotherapist) is recommended
- Having patients differentiate symptoms of BPD and asthma is an important goal

References: Clifton-Smith et al. 2011, Depiazzi et al. 2016, Thomas et al. 2005, Demeter et al. 1986, Saisch et al. 1996, Thomas et al. 2001, Martinez-Moragon et al. 2005, Grammatopoulou et al. 2014, Heaney et al. 2005, Radhakrishna et al. 2017, Weiss 1994, Bruton et al. 2011, Jones et al. 2013

Developed as part of the: SEVERE ASTHMA TOOLKIT
toolkit.severeasthma.org.au

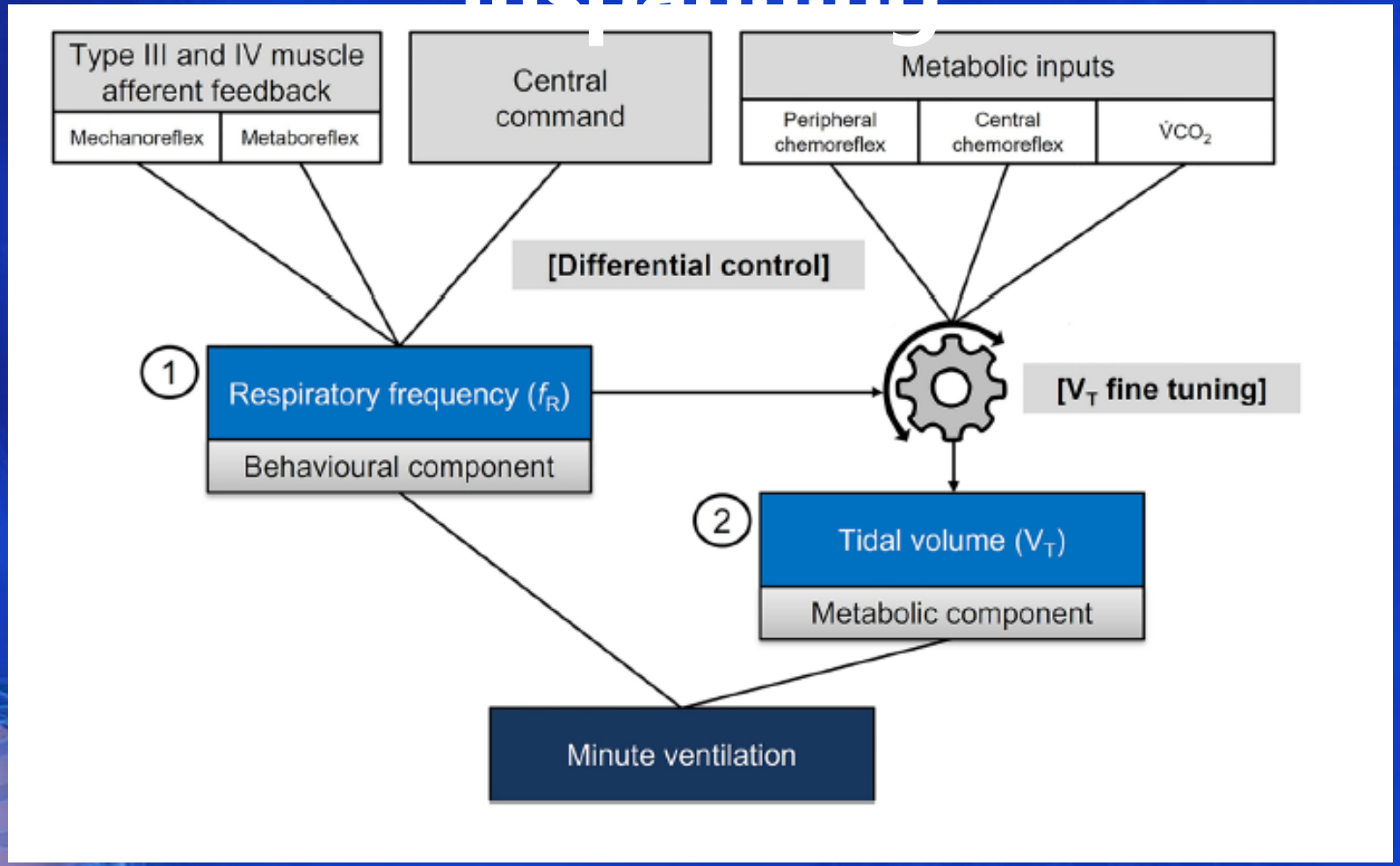
When you can Control your breath
You Can Control your Life

Masterclass Dysfunctioneel Ademen: Diagnostiek & Therapie – 15 juni 2023.

- Plaats: Bilthoven
- Doelgroep: Sportartsen (VSG/SKA), longartsen, kinderartsen (NVK), algemeen fysiotherapeuten (KNGF), long/hartfunctie laboranten, inspanningsfysiologen en overige geïnteresseerden.

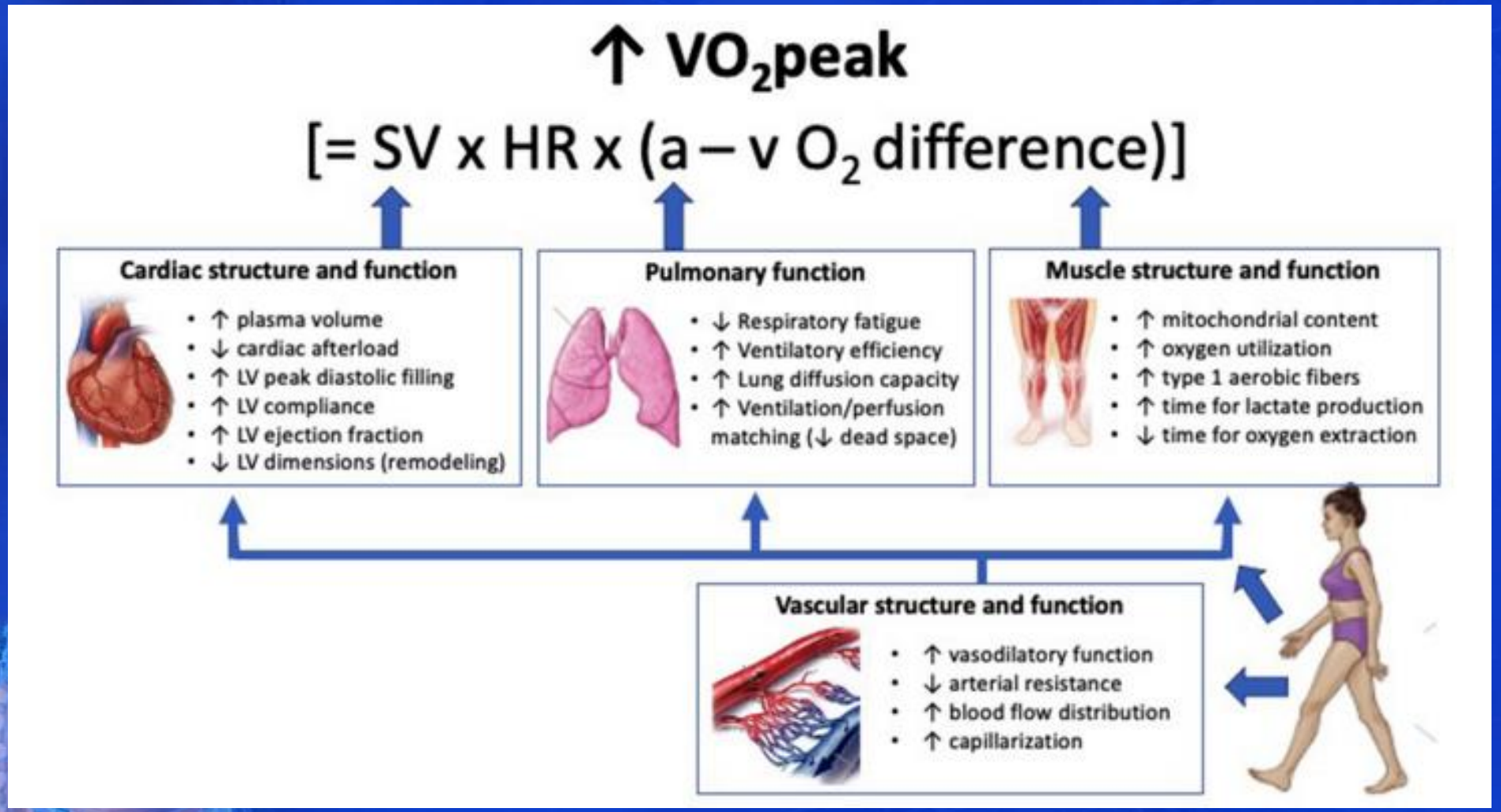
www.physiology-academy.nl

Functioneel model: Ventilatie tijdens inspanning



- European Journal of Applied Physiology. https://doi.org/10.1007/s00421-022-05077-0

Effecten van trainen



- *Taylor JL, Bonikowske AR, Olson TP (2021) Optimizing Outcomes in Cardiac Rehabilitation: The Importance of Exercise Intensity. Front. Cardiovasc. Med. 8:734278.*