Hypatia vestibular rehabilitation bronze course May 2023

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Introductions, experience of vr and agenda setting

- Introduction
- How much VR have you done?
- What do you want out of today?

Overview (1)

- *'Dear colleague please see this patient for vestibular rehabilitation…'*
  - What happens in an acute vestibular insult
  - Theory of compensation
  - Who will benefit from VR, red flags
  - How to devise a tailored made plan with a patient
  - How and when to follow up and discharge

- Practical session
  - Practise in devising a tailored made plan given a patient and their history

- How to modify the basic plan for bilateral hypofunction, visual vertigo, the older patient, remote VR?

Overview (2)

- Scenarios
  - Group discussion on example cases and how to manage
- Group discussion
  - What do people do in their departments and/or how to start a vr clinic
- Group discussion (if time)
  - Delegates to bring their own case histories for discussion

But first- and important question:
Why should we be impressed by the humble goldfish?

Patient referral

- *'Dear colleague please see this patient 30 year old female for vestibular rehabilitation..'*
  - She reports an episode of acute rotatory vertigo for 36 hours (in the absence of hearing loss) followed by movement-evoked imbalance. She was admitted to A and E where a stroke was ruled out
  - *Acute vestibular syndrome: central or peripheral?*
  - Testing was normal with the exception of
    - A right-sided 40% canal paresis
    - Low gain on right ward horizontal video head impulse with a mixture of overt and covert saccades

Theory: What happens in a peripheral vestibular asymmetry?

- Tonic and dynamic asymmetry in the vestibular system
- Gain of VOR reduced and vestibular spinal reflex (VSR-postural control) disrupted

- Reduced VOR gain causes:
  - Disequilibrium during head movement = 'catch up of the world'

- VSR disturbance causes:
  - Ataxic gait
  - Widened base of support
  - Veering when walking

What happens in a peripheral vestibular asymmetry (2)?

- In addition patient will report
  - Poor balance in the dark (taking away working input)
  - Poor balance in busy visual environments (visual vertigo)

- All these symptoms *may* lead to:
  - Inability to work
  - Increased chance of falling
  - Avoidance behaviour: of movements and social activities
  - Depression and anxiety

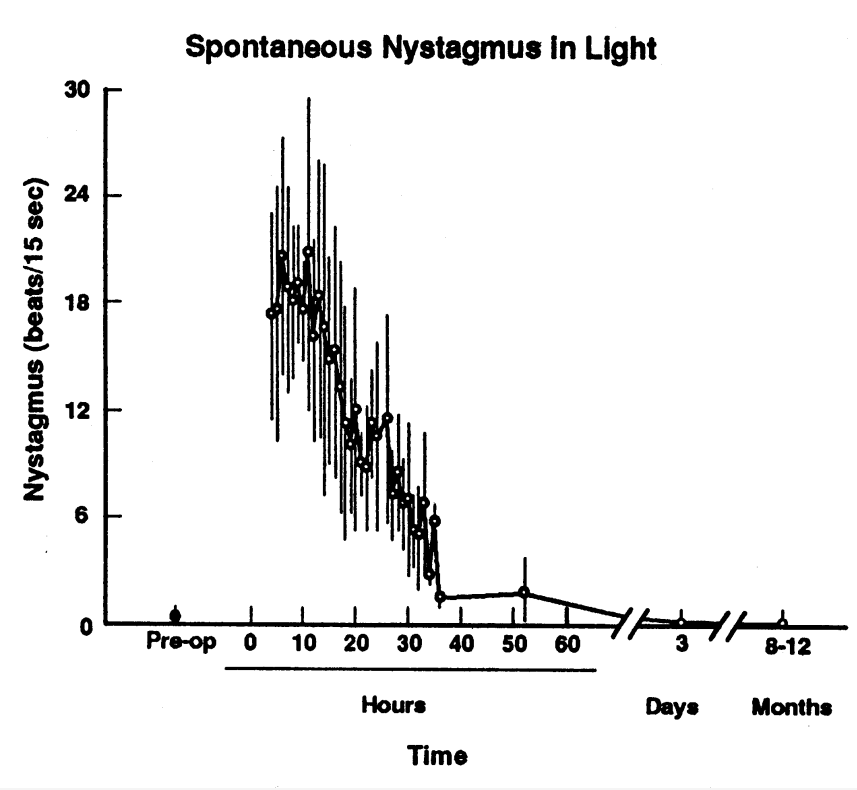
The good news ! Recovery and central compensation

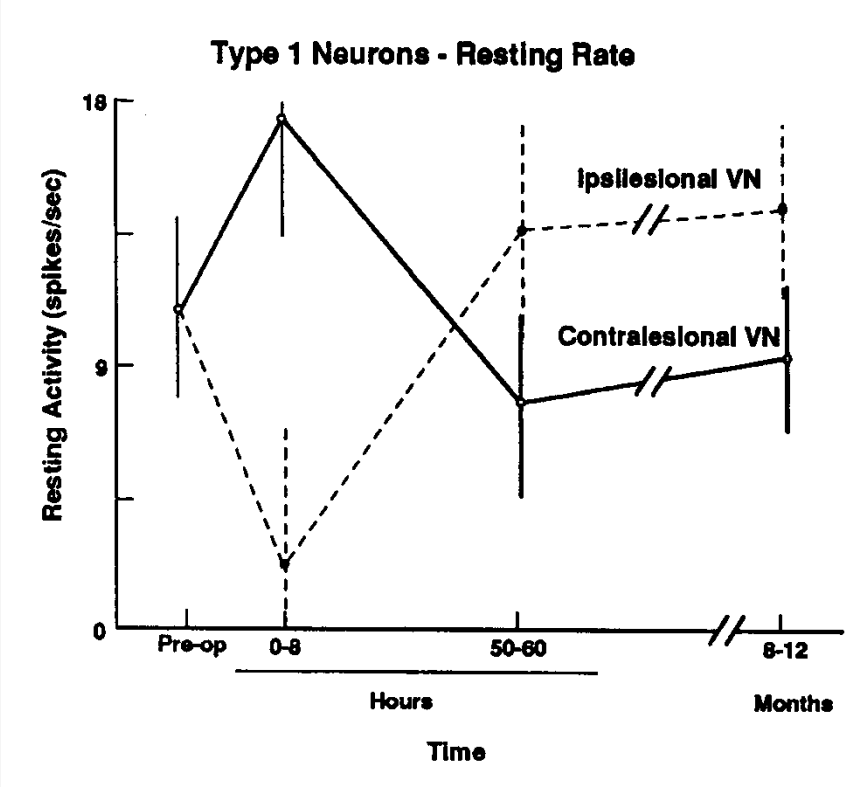
- **Tonic/static** asymmetry resolves:
  - Spontaneously
  - Completely

- **Dynamic asymmetry** resolves:
  - Often incompletely
  - Requires movement, visual input, takes longer

- *Speed and degree of recovery increased by vestibular rehabilitation exercises*

Acute UVL in Guinea Pigs (static asymmetry)

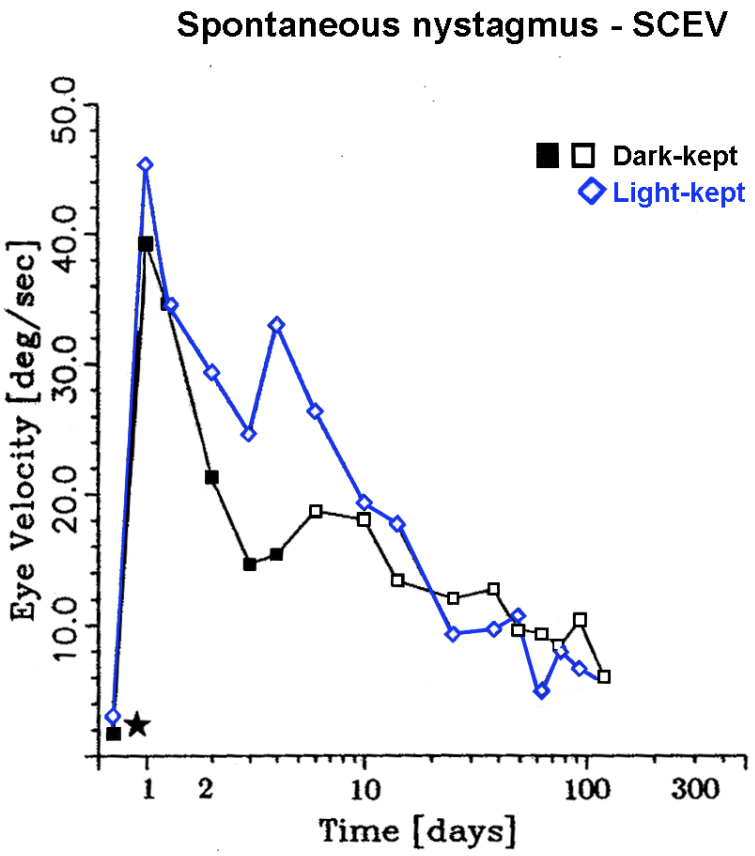




Drop followed by increase of resting activity (and disappearance of SN) of ipsilateral side as static compensation occurs

Smith and Curthoys 1988

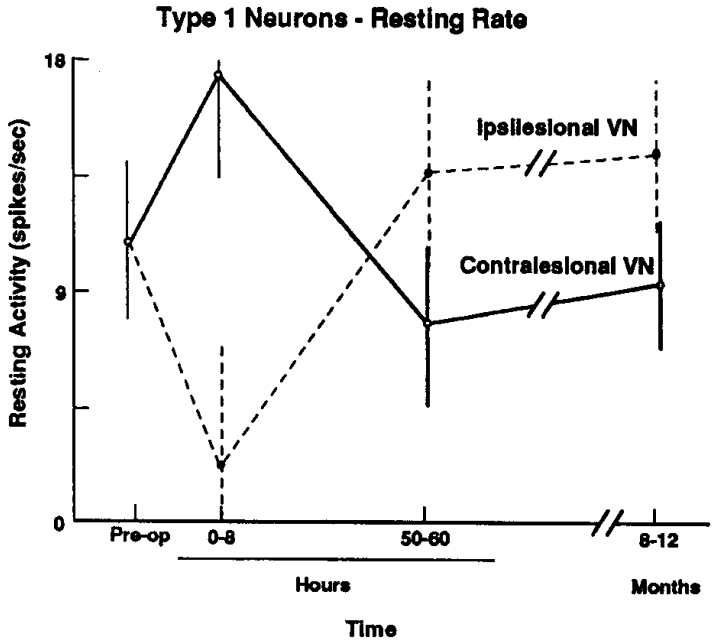
Resolution of spontaneous nystagmus (with fixation- ie static asymmetry) in monkeys- *not light/ mvt-dependent*

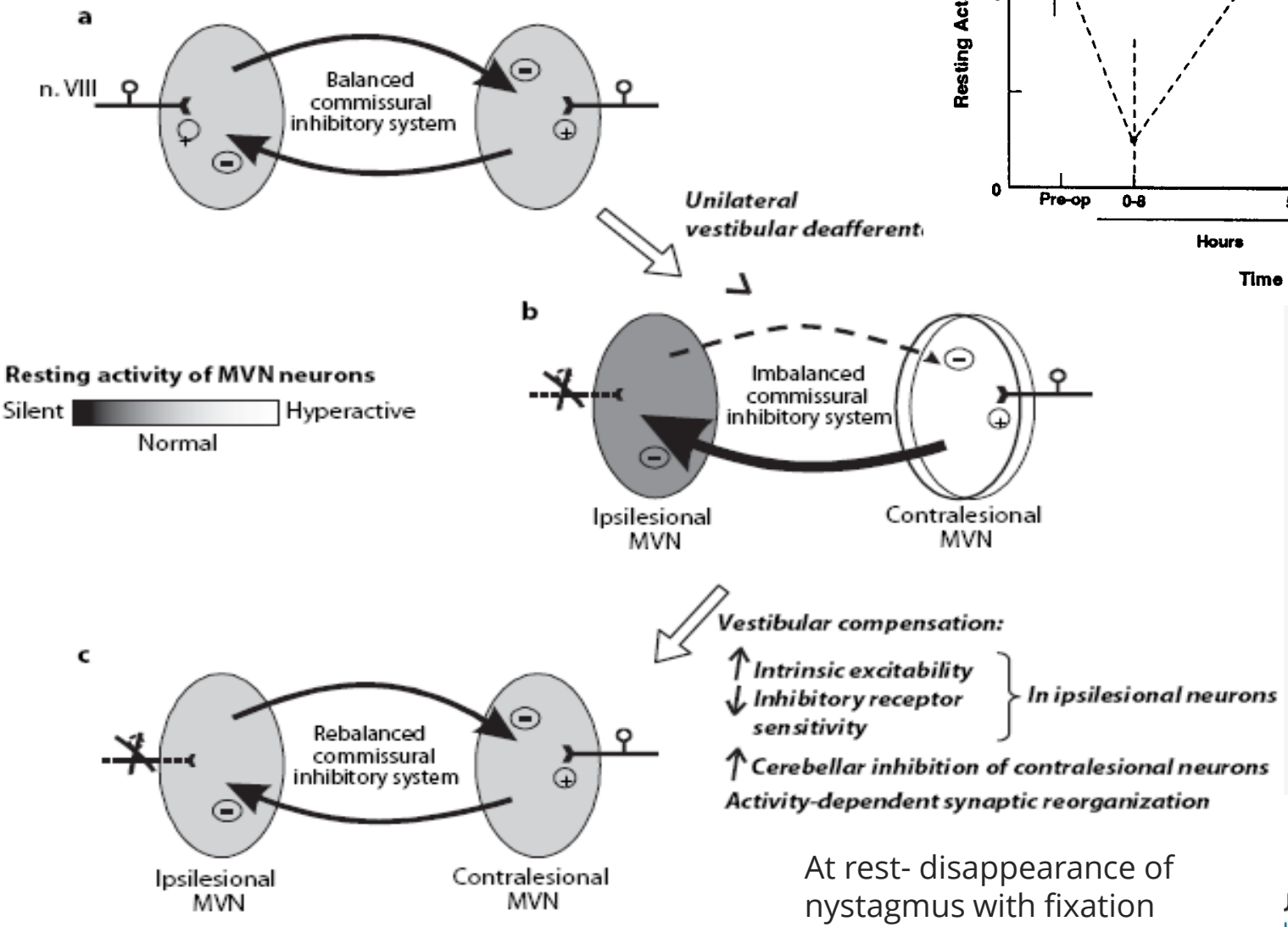


Fetter et al J Neurophys 1988

Static asymmetry rebalancing

Patterson 2004





↓Cerebellar clamping of VN (ipsi)

↑Cerebellar clamping (contra)

At rest- disappearance of nystagmus with fixation

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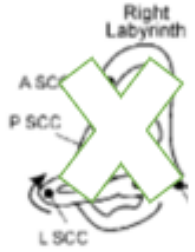
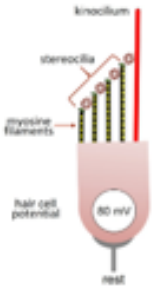
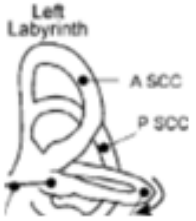
Completion Of Static Compensation

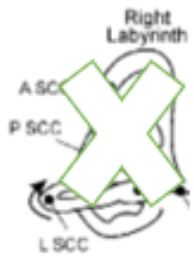
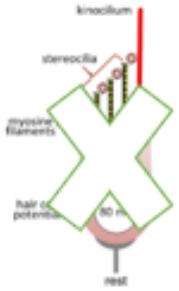
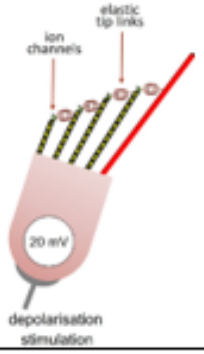
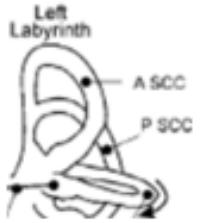
(Tonic Neural Activity In Bad Side VN Matches Good Side)

RIGHT SIDED LESION / NO HEAD MOVEMENT – INCREASED NEURAL ACTIVITY IN RIGHT VN AND LEFT VN – STATIC COMPENSATION						
STATUS OF RIGHT HSCC	RIGHT VESTIBULAR NERVE FIRING RATE	RIGHT VESTIBULAR NUCLEI	EYE MOVEMENT	LEFT VESTIBULAR NUCLEI	LEFT VESTIBULAR NERVE FIRING RATE	STATUS OF LEFT HSCC
ABNORMAL	0/S	100/S	NO NYSTAGMUS	100/S	100/S	NORMAL
						
	No baseline firing rate		DIFF BTW RIGHT & LEFT VN = 0/S			

With thanks to Paul Radomksij

Dynamic Compensation

(creation of new templates of neural responses to different head rotations)

RIGHT SIDED LESION / WITH ROTATION 25DEG/S – NEED FOR DYNAMIC COMPENSATION!						
STATUS OF RIGHT HSCC	RIGHT VESTIBULAR NERVE FIRING RATE	RIGHT VESTIBULAR NUCLEI	EYE MOVEMENT	LEFT VESTIBULAR NUCLEI	LEFT VESTIBULAR NERVE FIRING RATE	STATUS OF LEFT HSCC
ABNORMAL	0/S	100/S	LEFT BEATING NYSTAGMUS E.G 12 DEG/S	150/S	150/S	NORMAL
						
	No baseline firing rate and therefore no change		DIFF BTW RIGHT & LEFT VN = 50/S (1/2 WHAT IT WAS BEFORE – ABNORNAL GAIN)			

With thanks to Paul Radomksij

Compensation from dynamic asymmetry

- The result of multiple processes occurring in parallel
  - Changes in synaptic responsiveness & organization
  - Changes in intrinsic neuronal discharge rate
  - Changes in cerebellar control of neuronal functioning

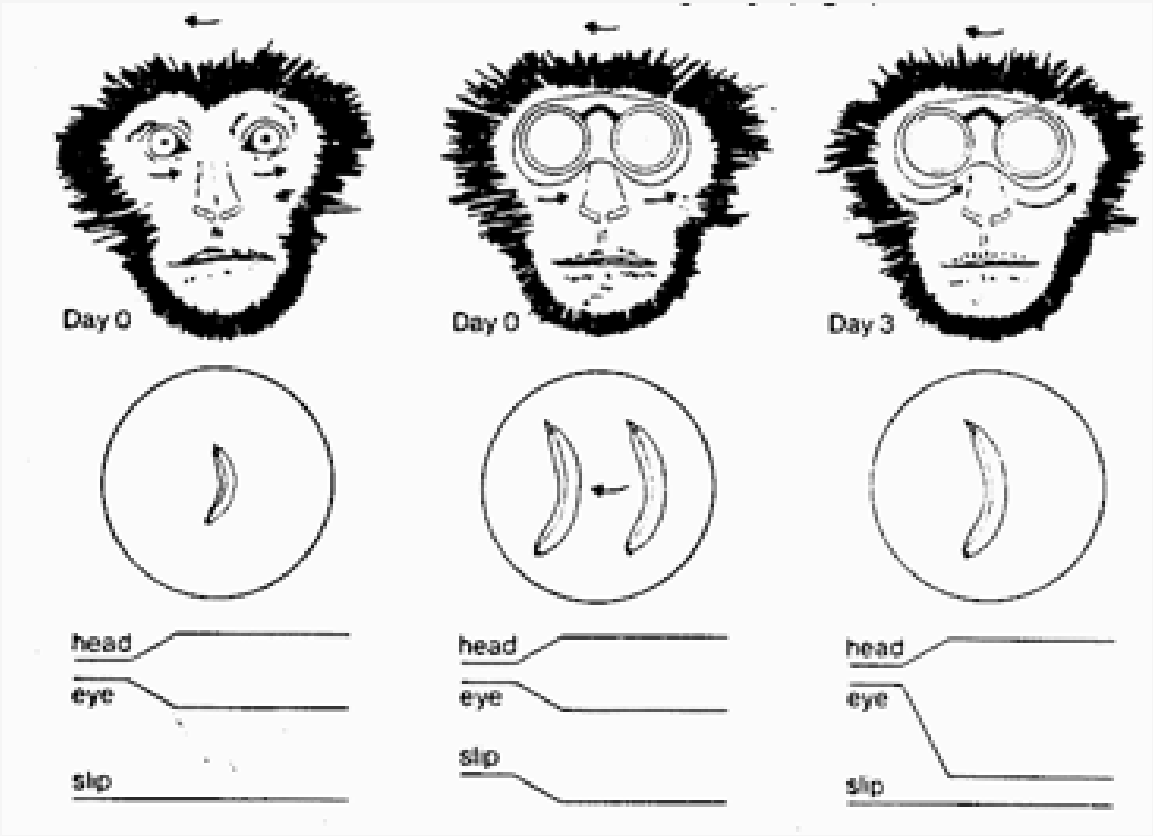
- Three main processes
  - Vestibular adaptation
  - Habituation
  - Substitution

- Functional recovery (reduction of symptoms) can occur with all or some of above depending on site of lesion

Vestibular Adaptation

- Ability of vestibular system to make long term changes in the neuronal response to asymmetrical input: plasticity of the brain
- Recovery/increase of VOR gain (and VSR)
- Needs retinal slip (movement of the visual image across the retina)
- Brain tries to ↓ error signal by ↑ gain

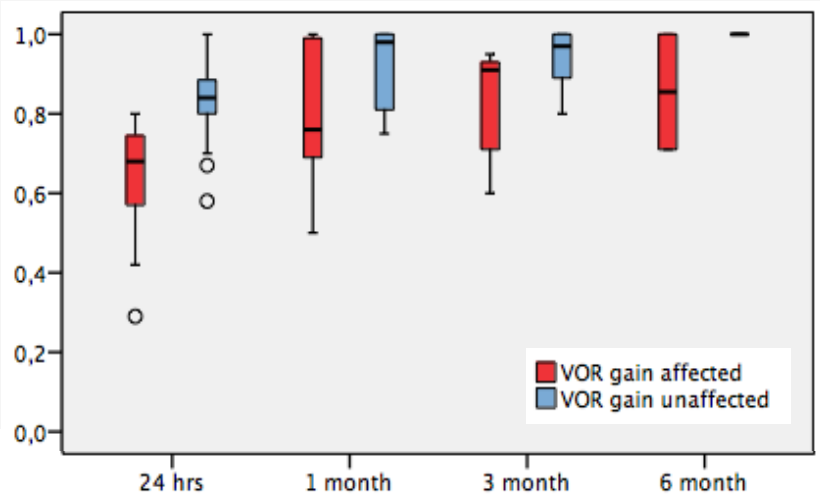
Occurs in normals (retinal slip) (eg with new glasses)



1. Rotatory chair , no slip
2. RC + magnifying lenses causing slip
3. After 3 days adaptation occurs causing increase vor gain, and stopping retinal slip

Vhit and gain recovery (with thanks to Dave Jay)

- Gain and the morphology of the VOR eye curve can RECOVER!
  - vHIT gain returned to normal in **all 18** vestibular neuritis patients (Martin-Sanz *et al.,* 2017)
  - VHIT gain returned to normal in **15/ 29** cases of vestibular neuritis (Bartolomeo *et al.,* 2014)
  - vHIT positive in 63% of acute patients (<5 days since onset), but only 33% of non-acute patients (>5 days) (n=172) (Mahringer and Rambold, 2014)



From Martin-Sanz *et al.,* (2017)

Habituation

- A reduction in symptoms caused by repetitive exposure to the movement which evokes the dizziness
- Occurs due to the central process of neural plasticity but is not well understood

Substitution

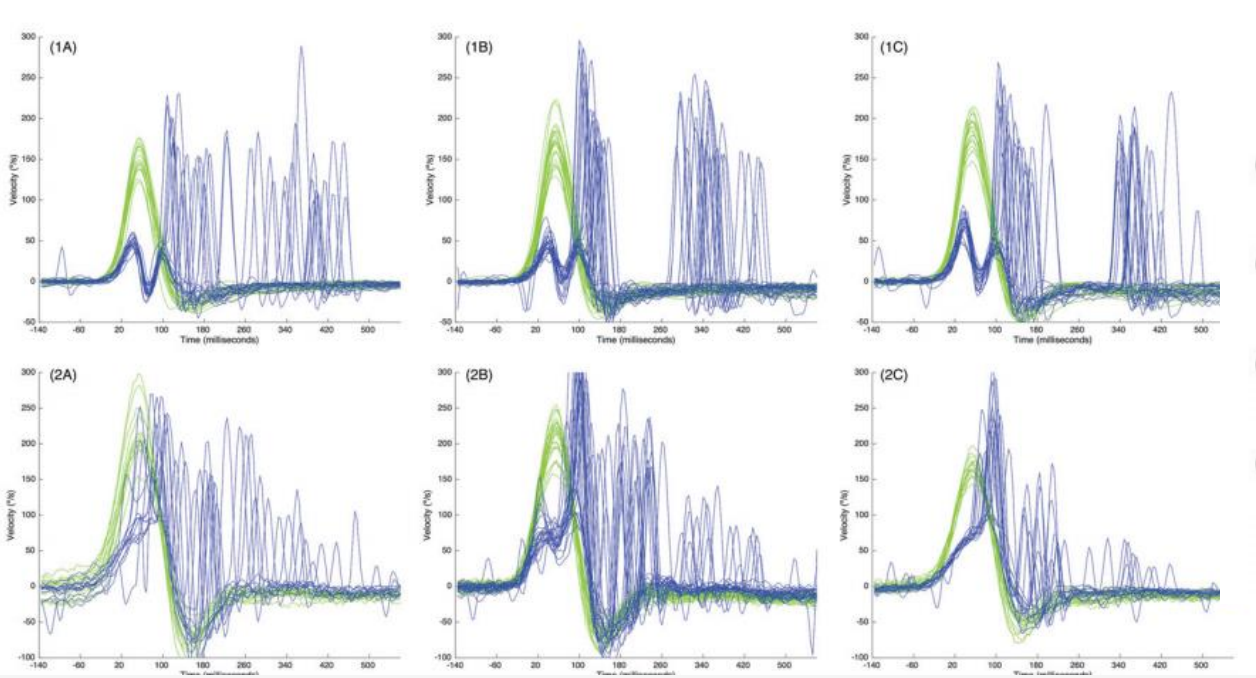
- Substitution, or reweighting of importance of other visual and proprioceptive cues/ strategies to replace the lost or impaired function
- Development of alternative strategies to help maintain balance in absence of vestibular function
- Occurs via
  - **Pre- programmed saccades**, saccade modification
  - reweighting of cues in visual vertigo patient
  - (cervical somatosensory cues (COR)- slower than vor so 2nd best option unless BVL, and not large contribution)
  - (upweighting of smooth pursuit (BVL).. Again not large contribution

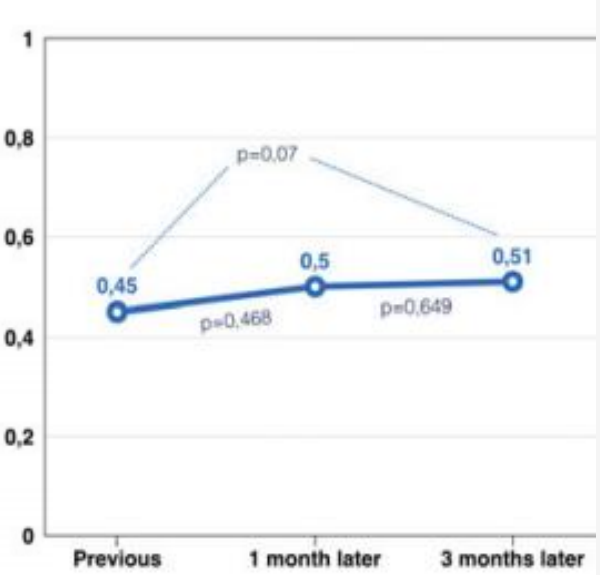
Pre- programmed saccades

- BVL patients generate covert saccades *ie not vestibular function dependent..*
- We don't know!
- ?? Cerebellar generated- shimp research in those with bvl vs cerebellar lesions show that bvl can generate them, but those with cerebellar lesions cant…
- ??Older theory… triggered by sensory input from neck (neck afferents) at onset of head impulse

Effects of central compensation on saccades

16 patients with unilateral vestibular loss before vestibular rehabilitation (A), at 1 month (B) and 3 months (C) (Matiñó-Soler *et al.,* 2016)





Gain did not significantly recover,
Overt saccades: in number and amplitude, <u>became more clustered</u>, and progressively ↓ in latency becoming covert

With thanks to Dave Jay

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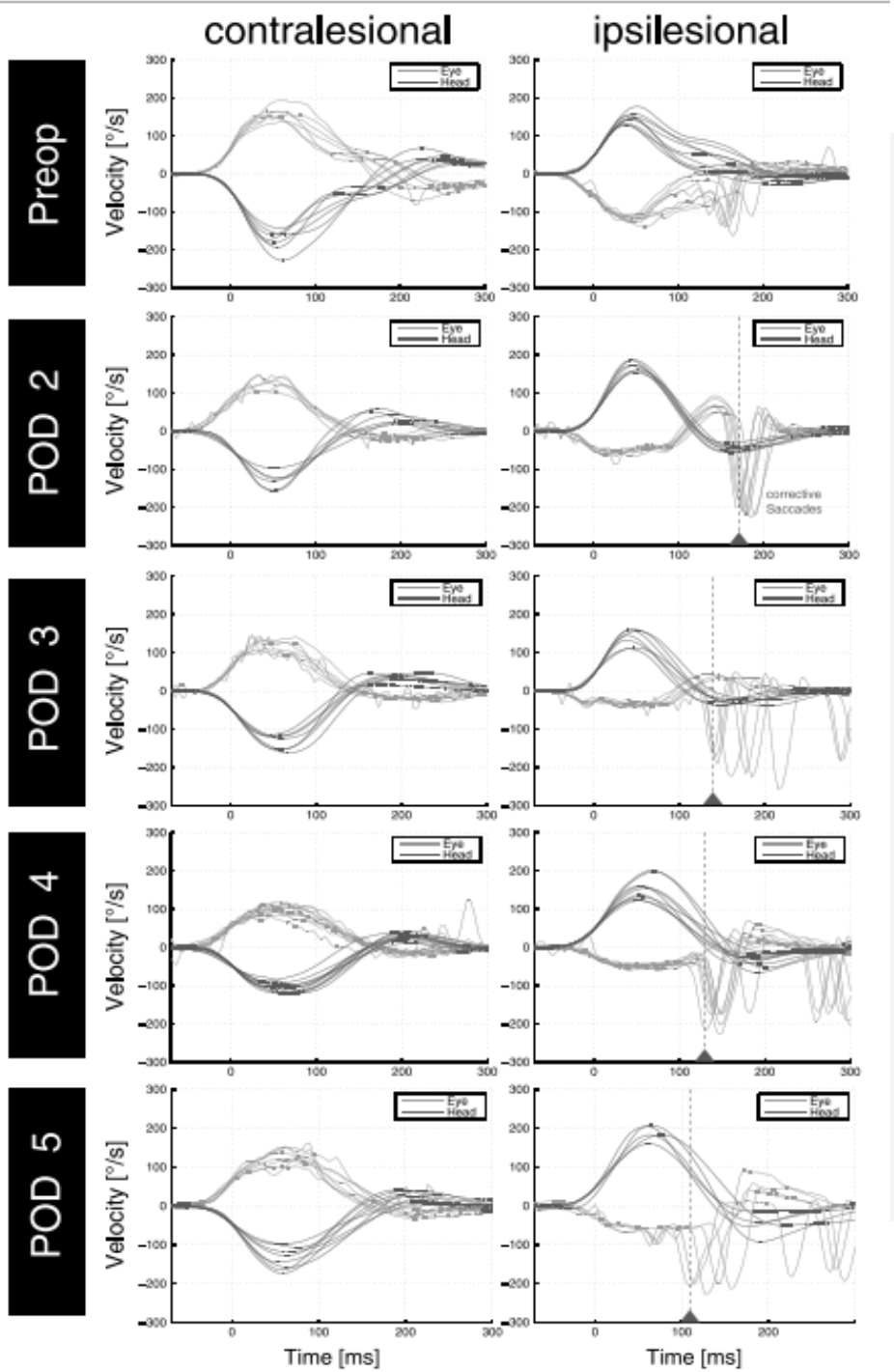


Change in saccades from overt to covert

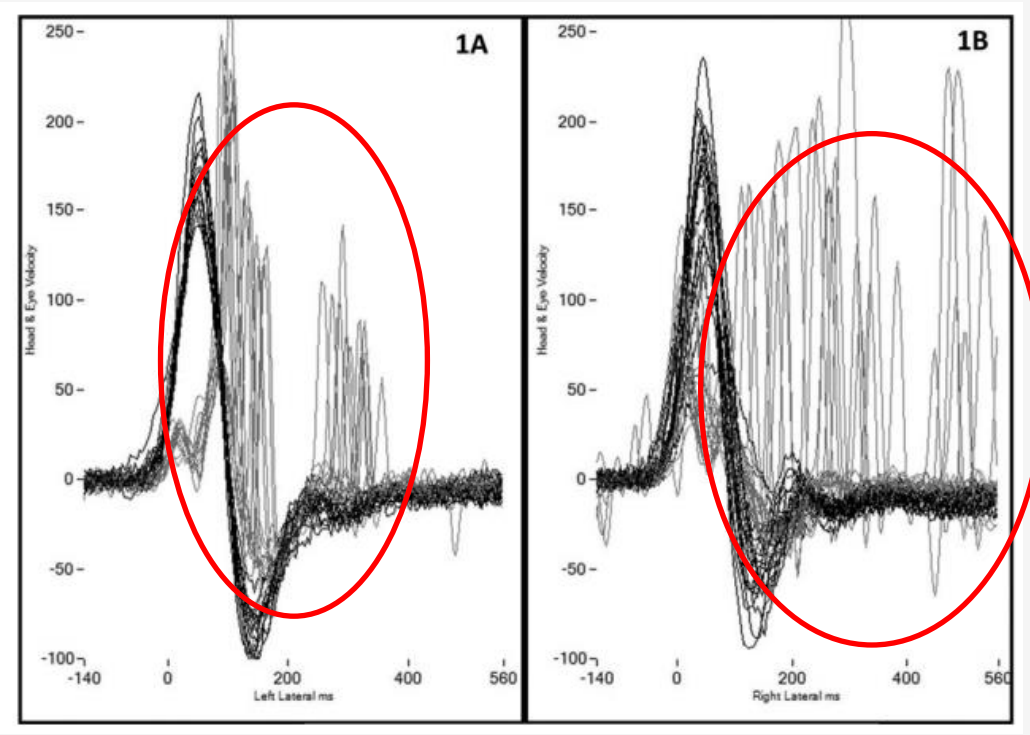
Unilateral deafferentation surgery (for VS)

From Mantokoudis et at al 2014

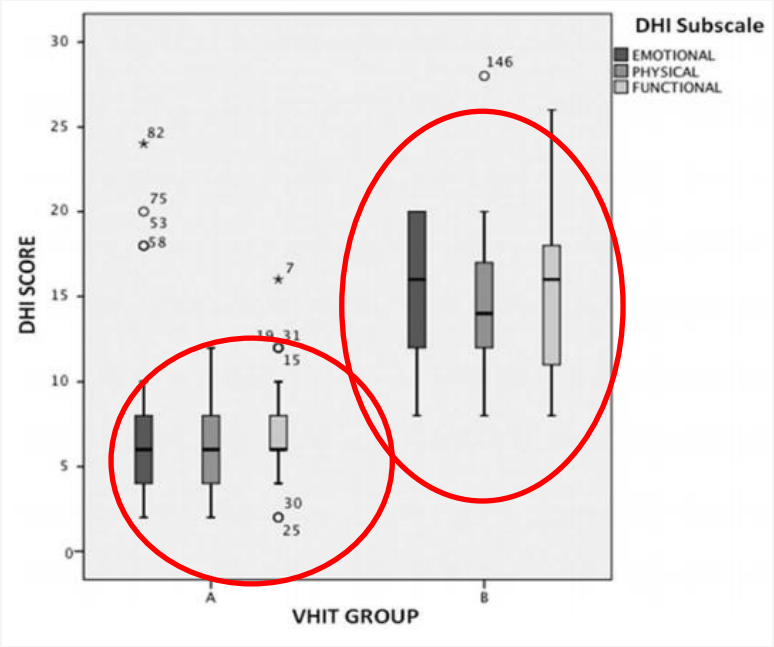
Saccades and subjective symptoms

With thanks to Dave Jay (Batuecas-Caletrio *et al.*, 2013).

- n = 49, complete unilateral deafferentation 1year after surgery



Group A = More gathered/clustered/organised
Group B = Less gathered/clustered/organised



A greater degree of scatter correlated with worse subjective report

Covert saccades may be **clues** to an <u>old, probably well compensated injury</u>

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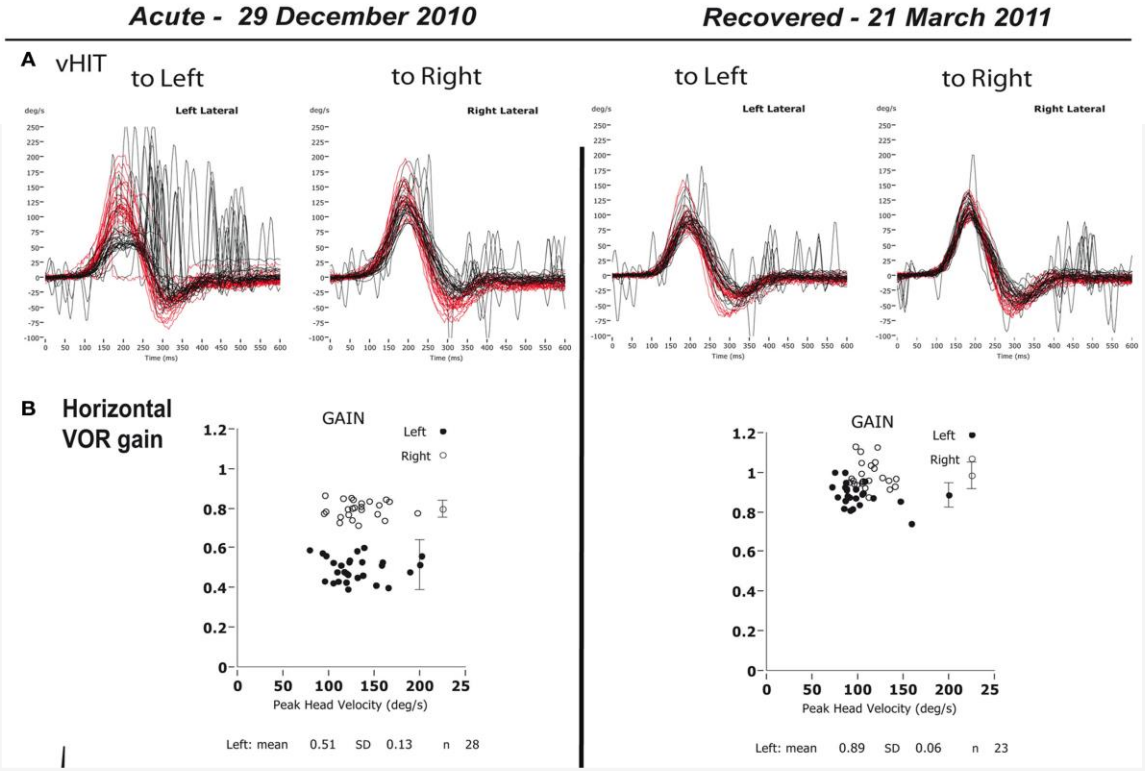
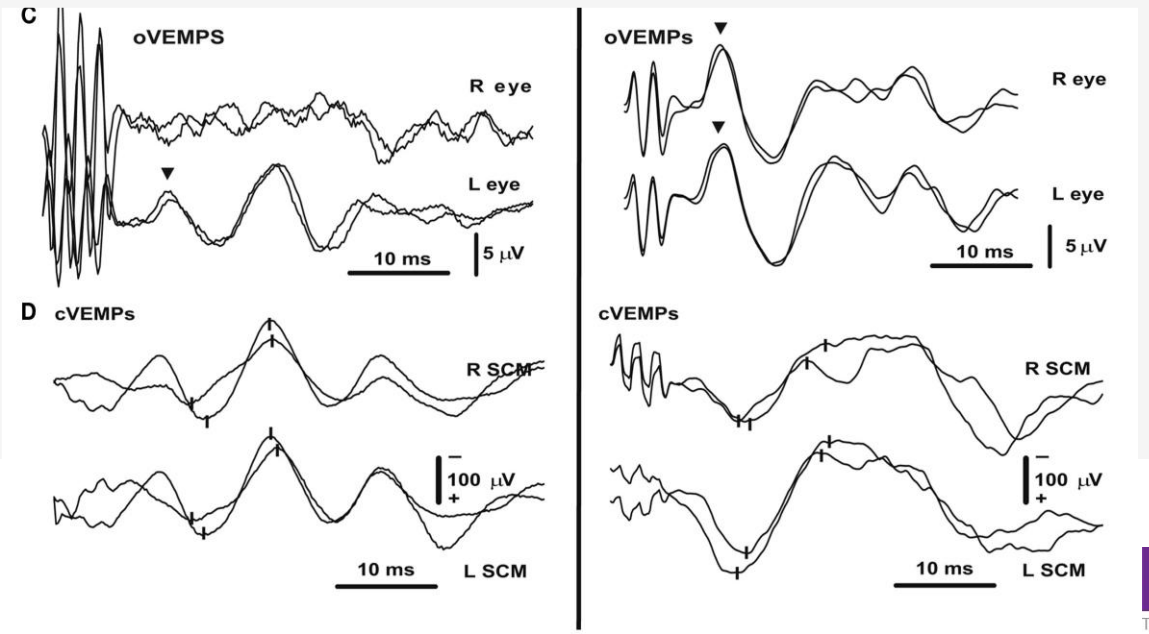
From MacDougall and Curthoys 2012





Recovery of function

Low gain left and catch up saccades→normal gain

No corrective saccades needed

Restoration of left o-vemp
Superior nerve neuritis

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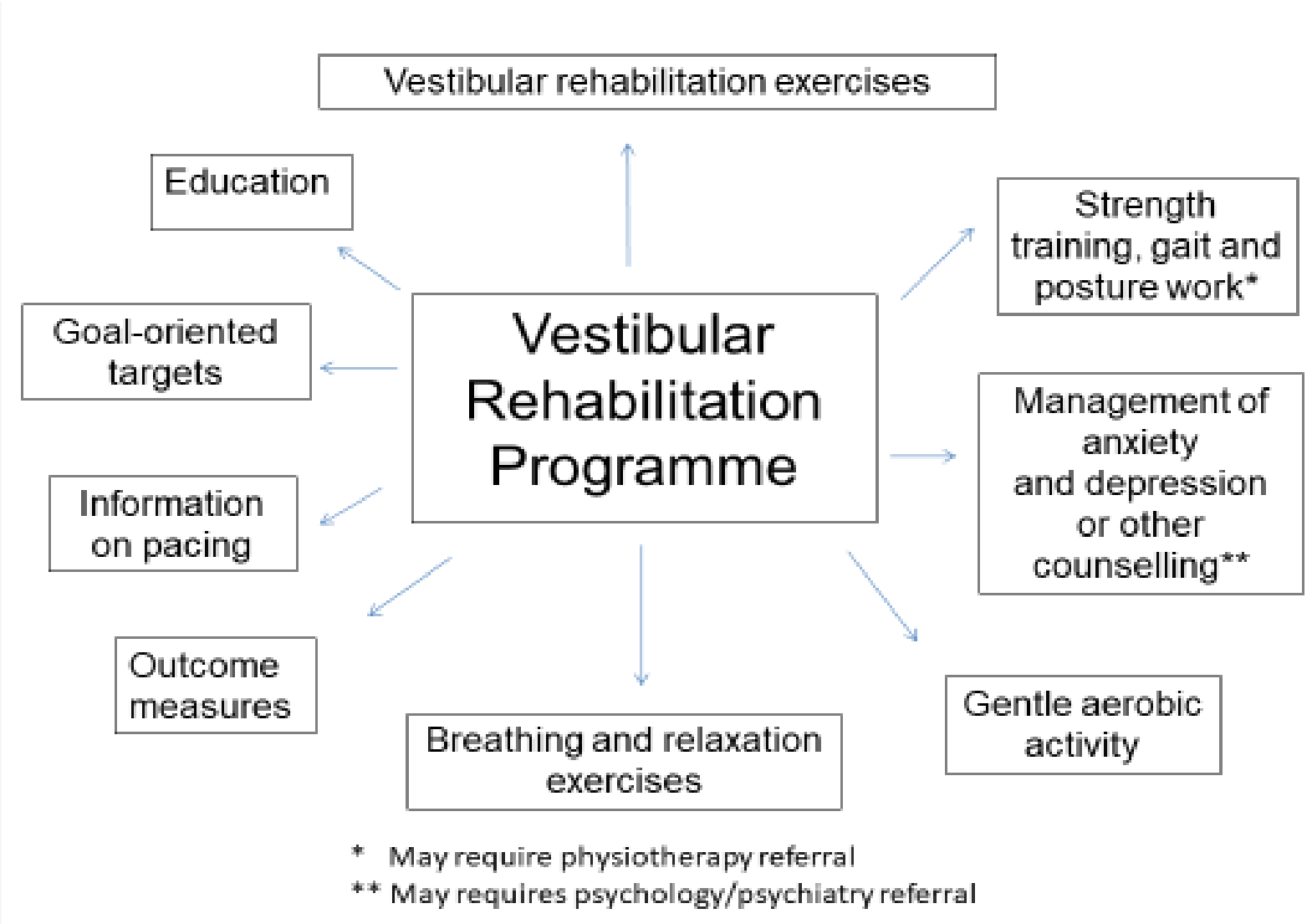
Theory over! Time for a break/ to breathe!

What is VR?

- **A graded tailored set of exercises** (or Cawthorne Cooksey *)
  - designed to mildly evoke patients symptoms of dizziness or imbalance
  - This error signal prompts the brain to recalibrate or compensate
  - *Cawthorne Cooksey- generic exercises focussing on habituation

- **Other components where appropriate**
  - education, breathing and relaxation exercises, counselling and gentle aerobic activity
- **Should be holistic- so much more than just exercises!**



From BSA VR guidance document

Who is vr for?

- ‘Anyone with a stable peripheral or central vestibular problem, or anyone with a stable balance problem from multiple causes’

- ‘VR is most effective when the vestibular condition is stable (ie not fluctuating or progressive), whether the diagnosis has a peripheral or central cause.’

- **Not for:**
  - A fluctuating problem eg active Menieres
  - BPPV- use Epley manoeuvres

From BSA VR guidance document

Evidence base

- Cochrane review updated 2015 (Mcdonnell et al)
  - 39 studies, n= 2441 with unilateral hypofunction
  - *Moderate to strong evidence*

  - Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: *An Updated Clinical Practice Guideline From APTA (J Neurol Phys Ther 2022)*
  - 70 studies (1985-2015), 67 studies (2016-21)
  - ***Strong evidence for VR***

- Some patients with a stable central vestibular disorder may improve to similar extent to those with a peripheral vestibular disorder, but rehabilitation will be slower (Brown et al 2006; Furman & Whitney 2000)

Overall summary from updated guidelines 2022

- **'VR recommendation increases from moderate to strong'**

- New evidence in support of **earlier initiation** of VPT, **within the first 2 weeks** of acute onset of UVH

- Support for consideration of a **variety of balance training modalities**, including low technology, virtual reality, optokinetic stimulation, platform perturbations, and vibrotactile feedback
- **Supervised VPT** promotes adherence and continued participation in VR exercises and may lead to improved outcomes

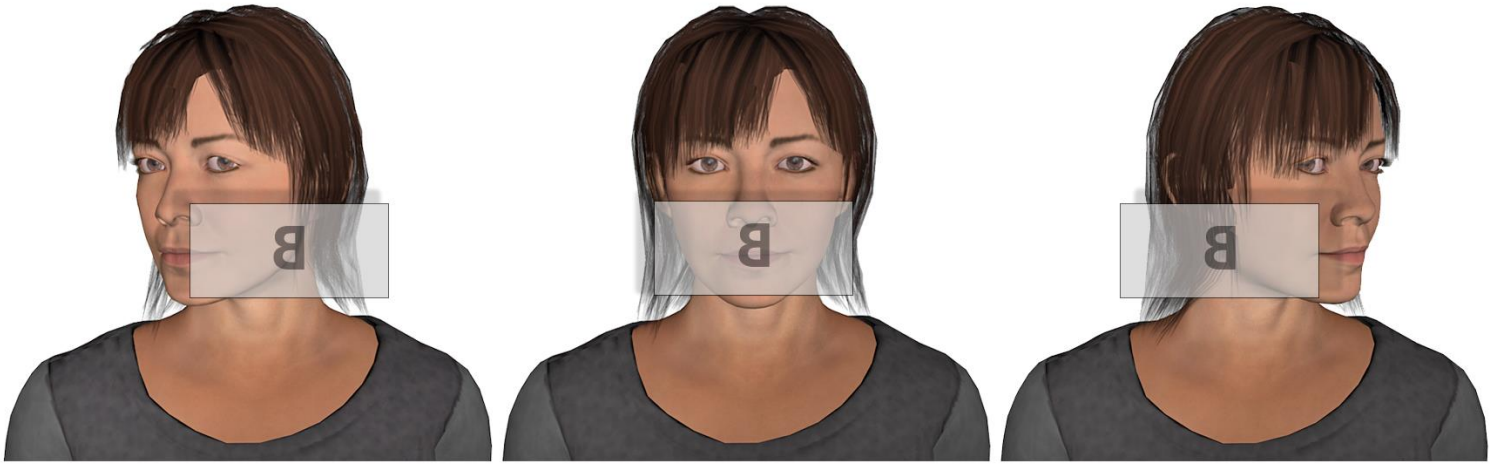
- **No studies** specifically examine frequency, duration, or exercise intensity as factors that influence treatment efficacy for individuals **with BVH.** Nevertheless, it is possible to make some preliminary suggestions about exercise dose based on the clinical experience of the GDG and compilation of evidence from several studies.

- **Cognitive impairment or moderate to severe mobility dysfunction** may lead to attrition if unsupervised, potentially leading to **limited improvement**

Exercise types

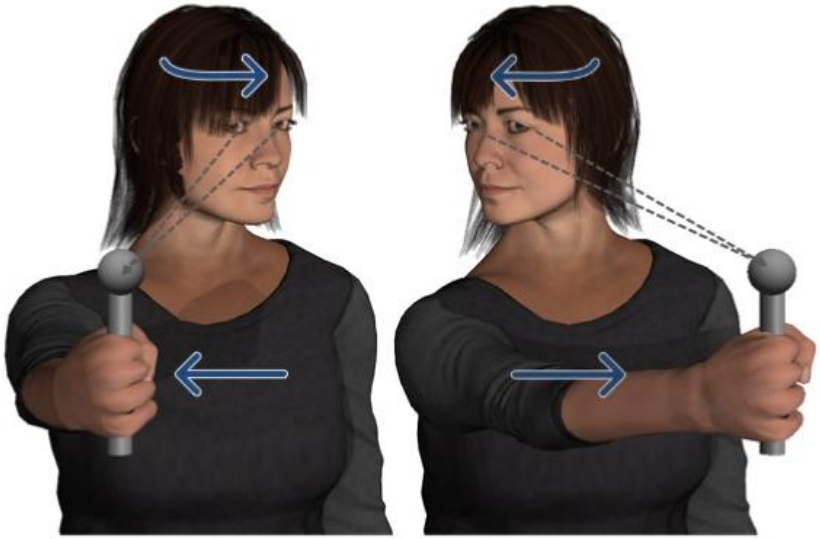
- Gaze stabilization
- Head and body movements
- Standing balance
- Walking balance
- Visual vertigo- reduce visual sensitivity
- Patient-voiced

Herdman's Gaze Stabilization Exercises



X1 paradigm

https://youtu.be/2-Zj9hVXHQw horizontal
https://youtu.be/BSjw9LFYbwg vertical
https://www.youtube.com/watch?v=mNqW-Zv7nd8 colours and letters



X2 paradigm

https://youtu.be/-3Fw_qLSkqU

Habituation: Head and body movements

- Head turn/nod/lateral flexion *(60s where possible)*
  - Eyes open/closed
  - Sitting or standing
- Turning in swivel chair or in circle standing
  - Eyes open/closed
- Other body movement exercises
  - Eg From lying to sitting
  - Bending down picking up an object, standing

Standing exercises

- Romberg
- Sharpened Romberg
- One leg stance
- Foam

Sharpened Romberg
eyes open

www.pacifu.edu

Romberg eyes closed

Walking and patient voiced

- Walking exercises
  - With or without head turn/nod (crossing the road)
  - Heel to toe walking
  - Walking and stepping over object (elderly)
  - Walking slowly with eyes closed

- Patient voiced
  - Whatever important to patient and evokes symptoms

Outcomes

- Outcomes depend on
  - If central structures are affected
  - migraines
  - Taking of vestibular suppressants
  - Cognition
  - Supervision and adherence to program
  - Anxiety and depression
  - Sleep

- It is not dependent on:
  - Age
  - Symptom duration

For references see BSA doc

How do you give VR?

- No one right way (lots of wrong ways!)
- Ill show you how I treat a patient with VR as an audiologist
- Always work within your remit- refer on if necessary

- VR often needs a MD approach eg
  - If musculoskeletal problem (physio)
  - If constant dizziness (specialist area)
  - If secondary psychological problem (IAPT or clinical psychologist)

Stages of Vestibular Rehabilitation

- History of evoking symptoms
- Vestibular benefit rehabilitation questionnaire or other symptom questionnaire
- Formal VR assessment (and other tests)
- Education
- Tailored plan devised and shown
- Goal setting
- Written information
- Follow ups

Assessment

- Outcome measures* (see hand outs and APTA/end of pres)
  - Lots of these- need to review the evidence base and decide what is most useful for your patients
  - I use VRBQ for all
  - Tug, DGI and ABC for elderly patients
  - Mixture for PPPD/anxiety

- History of:
  - Movements and activities that cause dizziness and those they avoid
  - Identification of any psychological overlay
  - Barriers to success of VR programme

* Stewart VM, Mendis MD, Low Choy N. (2018) A systematic review of patient-reported measures associated with vestibular dysfunction. *Laryngoscope*. 4:971-981

Assessment of symptoms caused by:

- Head and eye movements (VOR)
- Head and body movements
- Walking ability
- Standing balance
- Visual vertigo
- Specific patient voiced provocative movements

- Use of questionnaires where needed eg
  - motion sensitivity quotient
  - functional gait index
  - Dynamic visual acuity if bilateral hypofunction

Customised exercises. What I do...

- Choose a mixture of 5-6 exercises which mildly evoke symptoms
- Show patient and get them to perform in front of you
- Re-iterate: exercises to be performed:
  - Twice per day (5 x for VOR exercises)
  - At a level which just evokes symptoms
  - Let symptoms completely subside in-between each exercise
  - Use of grounding/breathing if very symptomatic

Guidelines (APTA guidelines (Neurology Section 2015 + 2022)

Recommendation	Strength
VR to acute/subacute/chronic unilateral and bilateral hypofunction	Strong
***Should not* offer saccadic or smooth pursuit (without head movement) for gaze stability**	Strong
Give targeted exercises to meet specific goals and reduce specific impairments/functional limitation	*Moderate* lack of quality research
Supervised vr	Moderate
Gaze stabilization for minimum of :** • ***Acute/subacute: 3 x per day, total 12 mins • ***Chronic (>2 wks) 3-5x, total: 20 mins (4-6wks)*** • ***BVL: 3-5 x, total 20-40 mins, (5-7 wks)***	**Weak but upgraded frm expert opinion*
Stop when achievement of primary goals, symptom resolution or plateau	Expert opinion
Evaluate factors that may modify rehabilitation outcome	Weak- strong
Harm/benefit (qol/psychological stress) offer vr	Strong

Level and repetitions: what I do

- How many exercises , how often and many repetitions?
  - 5- 6 exercises of different types
  - Gaze stabilization 60 + s 5x per day
  - Others 2x per day 60 s so evoke symptoms

- What level?
  - Always need to evoke mild dizziness/challenge balance system

What level? General principles

- Eyes open easier than eyes closed (unless visually vertiginous)
- Feet wide apart easier than close together

- Sitting easier than standing

- Slow movements easier than fast movements

- Eye movements easier than head movements easier than body movements/walking

More Advanced Exercises

- Exercises involving unplanned movements
  - Hitting ball against wall
  - Throwing and catching games
  - Patient walking in circle and person giving command eg turn around, touch the floor
  - Sports such as badminton, football

VR assessment (2)

- If patient keen to do VR:
- Explanation of condition and compensation process key to compliance and success
- Goal setting and setting expectations as to extent of recovery and time appropriately
- Agree specific times in day when patient able to do exercises (preferably 2 x per day)

Other things to include

- Importance of giving written information
  - How balance system works
  - How symptoms are caused
  - How exercises will help and are to be performed
  - Which exercises to do and number of repetitions
- Lifestyle modification and relaxation
- Tai chi/yoga or other light exercise

The importance of goal setting in vr
'the sky is not the limit…'

https://www.youtube.com/watch?v=xsp-ScIVQtY

Back to our patient

- In depth case history revealed
  - No additional health/musculoskeletal problems
  - Symptoms with all head movements, worse horizontal than vertical, faster worse than slow
  - *'World takes time to catch up and causes imbalance'*
  - Unsteady in the dark
  - Generally unsteady when walking
  - Looking from computer to document on desk
  - Stopped
    - socialising with friends 'just in case she gets a further attack'
    - going to gym as sit ups caused her to be dizzy
  - Worried that dizziness could be caused by a brain tumor

Dizziness and anxiety

Movement evoked dizziness

Vestibular rehabilitation benefit questionnaire

Total score: 35%

Quality of life

1. I feel dizzy

all the time	very often	quite often	sometimes	not very often	only very occasionally	never

2. I get a feeling of tingling, prickling or numbness in my body

all the time	very often	quite often	sometimes	not very often	only very occasionally	never

9. Looking up at the sky makes me feel

not at all dizzy	very slightly dizzy	mildly dizzy	moderately dizzy	really quite dizzy	very dizzy	extremely dizzy

10. Moving my head slowly from side to side makes me feel

not at all dizzy	very slightly dizzy	mildly dizzy	moderately dizzy	really quite dizzy	very dizzy	extremely dizzy

19. Compared to before the dizziness started, I avoid some activities, positions or situations

a lot more	quite a bit more	a little bit more	same as before	a little bit less	quite a bit less	a lot less

20. Compared to before the dizziness started, I am happy to be on my own

a lot more	quite a bit more	a little bit more	same as before	a little bit less	quite a bit less	a lot less

Our patient: Action Plan

- Patient actually relieved about CP- had been dismissed by GP
- Happy to try VR- tailored plan devised
- Goals:
  - To be able to go out for a meal on a Friday evening with a friend
  - To go to Pilates
- Times to do exercises
  - 645am and 6pm

What exercises would you give?

- Catch up of the world on head movement
- Imbalance on horizontal and vertical head movement
- Looking from computer to desk as make her dizzy

- Imbalance in the dark

- Imbalance walking with head movement

- Cant go to gym as makes her dizzy

Starting plan

Symptom	Exercise
Catch up of the world on head movement	X 1 standing 60s horizontally and vertically*
Imbalance on horizontal head movements	Horizontal head turns 30 s eyes open standing x 2
Imbalance on vertical head movement	Head nods 60 s eyes closed standing
Looking from computer to desk	Do this for 2 mins with breaks
Imbalance in the dark	Static standing 30 s feet together x 2
Imbalance when walking when moves head	Walk down hall head right, centre, right 2 mins with breaks
Sit ups	5 slow sit ups

Total time = 10 mins x 2 per day
* 5 x per day
Also: Arrange for quiet coffee with a friend

Follow up- what format and how often

- Patient and resource- specific
- Telephone vs face to face vs remote
- 4 weeks (or two weeks if very symptomatic)

Follow up: our patient

- Appt 2: VRBQ: 22% deficit
- Some improvement noted by patient but still quite anxious. Hadnt felt able to go for coffee

- Needed encouragement

- VRBQ showed
  - Patient her symptoms were improving
  - Encouraged her to continue
  - Discussed concerns re coffee

Follow up: How to make exercises harder?

- X2 > X1 (>= more difficult than..)
- X1 with busy background > X1 with plain background
- X1 with block of text > X1 with single letter

- Walking > standing> standing

- Eyes closed > eyes open (apart from in visual vertigo)

- Narrow base of support > wide base of support

- Quicker/larger movements > slower ones
- More repetitions/duration> less repetitions/duration

Table 5: Vestibulo-Ocular Reflex Progression.

	VOR x1	VOR x2
Firm, Feet Apart, 1 meter, White Background	1	3
Firm, Feet Apart, 3 meter, White Background	2	
Firm, Feet Apart, 1 meter, Complex Background	4	6
Firm, Feet Apart, 3 meter, Complex Background	5	

Activities are ranked numerically in order of increasing difficulty.
VOR: Vestibulo-Ocular Reflex.
Repeat sequence with: Firm, Romberg (7 – 12); Firm, Semi-tandem Romberg (13 – 18);
Firm, Tandem Romberg (19-24); Foam, Feet Apart (25 – 30); Foam, Romberg (31 – 36);
Foam, Semi-tandem Romberg (37 – 42); Foam, Tandem (43 – 48).

Suggested progression from Klatt*
However make patient specific! Don't *have* to do 1,2,3 etc and can have more than one exercise at once

*Klatt et al 'A conceptual framework for the progression of balance exercises in persons with balance and vestibular disorders'.

Table 2: Gait Progression.

	Walking Speed		
	Self-Selected	Fast	Slow
Forward, Firm, EO, No Head Movement	1	2	3
Forward, Firm, EO, Pitch head Movement	4	6	8
Forward, Firm, EO Yaw Head Movement	5	7	9
Backward, Firm, EO, No Head Movement	10		
Forward, On to/Over Foam, EO, No Head Movement	11	12	13
Forward, Firm, EC, No Head Movement	14		
Forward Tandem, Firm, EO, No Head Movement	15		
Backward, Firm, EC, No Head Movement	16		
Backward Tandem, Firm, EO, No Head Movement	17		

How to modify?

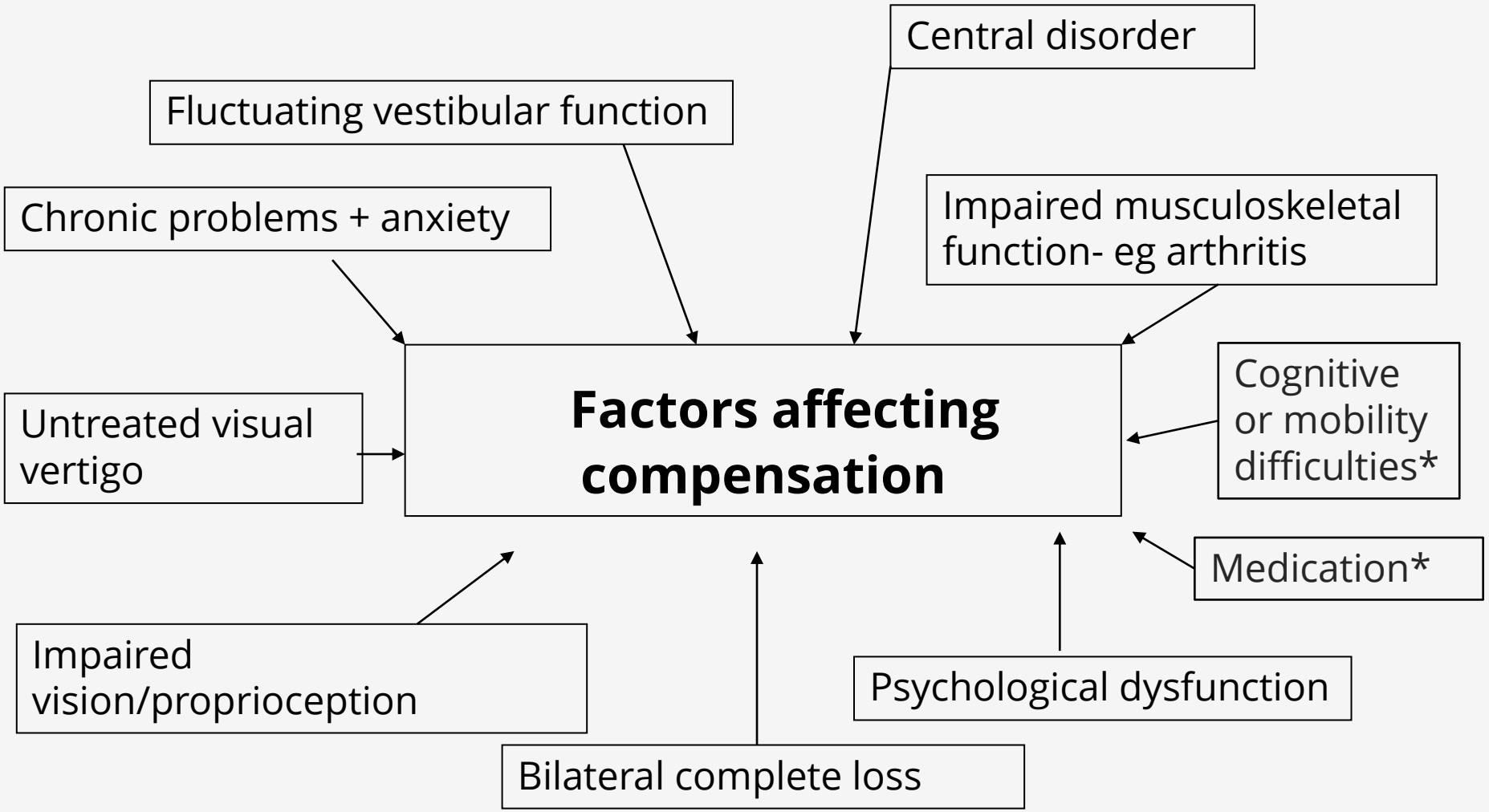
Old exercises	Modifications
X 1 standing 60s	Add busy background
Horizontal head turns 30 s eyes open standing x 2	60s without break 30 s eye closed standing
Head nods 60 s eyes closed standing	Stop as no longer symptomatic
Looking from computer to desk (2 mins)	Increase to 5 mins and some scrolling
Static standing 30 s feet together x 2	Semi heel to toe Feet together soft surface
Walk down hall head right, centre, right. 2 mins with breaks	With continuous, faster head turn
5 slow sit ups	10

FU2

- Was doing well and had managed to go for coffee with a friend without incident
- Got a bad cold
- Symptoms worsened, stopped exercises
- Feeling very disillusioned *'I will never get better'*
- *'have you missed anything?'*

Symptoms not improving or worsening

- 10-30% UVL and 25-66% BVL do not experience improvement
- Possible reasons no improvement:
  - Not a tailored package
  - Exercises not done correctly- too easy
  - Exercises not done at all
  - Other factors impeding compensation
- Possible reasons for worsening
  - Exercises done at too high a level overwhelming the system
  - Anxiety
  - Episode of decompensation

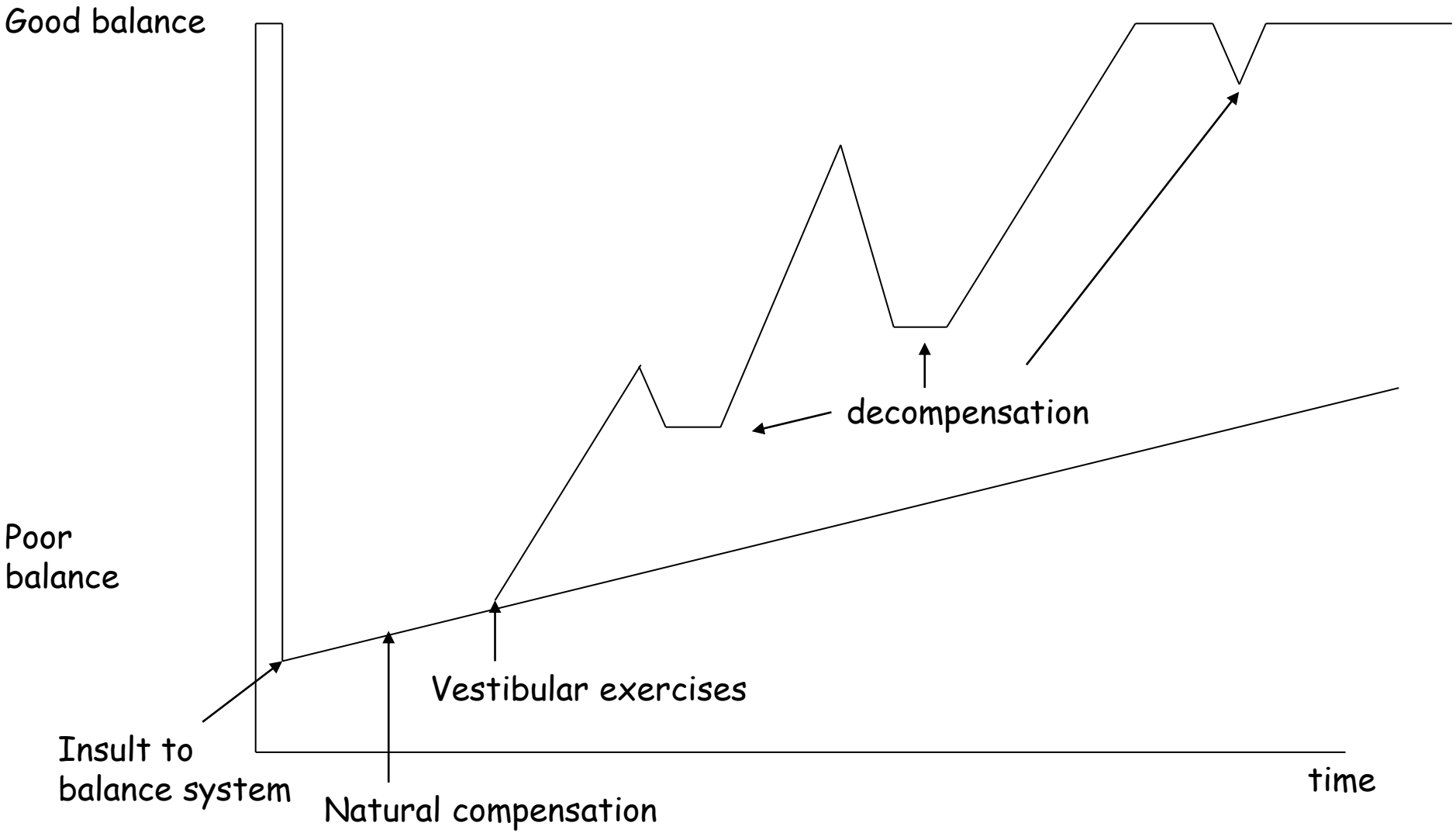


Episodes of decompensation may always occur

* From APTA 2022

Decompensation

- Symptoms of dizziness return (ranging from mild- moderate) but usually not as severe as first episode
- This is decompensation usually evoked by stress illness or tiredness
- Patient needs to get back to exercises at level which just evokes symptoms to promote recompensation


Good balance
Poor balance
decompensation
Vestibular exercises
Insult to balance system
Natural compensation
time

Back to our patient

- Discussed decompensation
- No she hadn’t got a brain tumour!
- Encouraged to get back to exercises
- Made exercises slightly easier but suggested made them more difficult over time

FU 3

- VRBQ 3: 1.5% deficit
- Goals met:
  - Had gone for meal with friend and started socializing more after she knew she could do this
  - Just started once weekly Pilates at gym
  - Doing Tai Chi
- Patient symptom-free when discharged!

Break/ Breathe… again !

Case history: Try it out on us!

Theory part 2

- Visual vertigo (basic overview)
- Bilateral vestibular loss
- Older patients
- Booklet/ online based approached

With thanks to Amy Lennox, Hypatia

Visual Vertigo results from being overstimulated by complex **visual** environments and/or seeing movement.

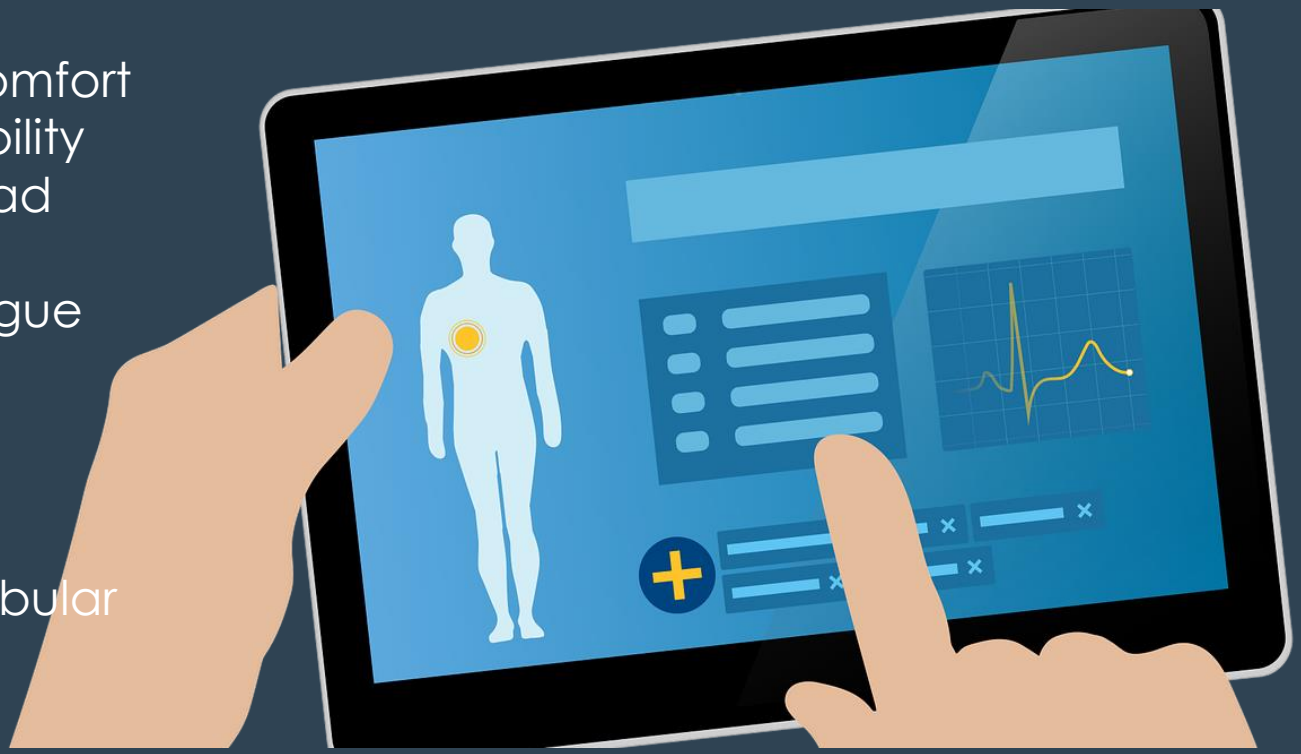
- Post vestibular insult over reliance on vision and increase in its sensitivity
- Visual vestibular conflict or intense visual motion stimuli lead to worsening of dizziness (especially when moving)

Visual vertigo/ visually induced dizziness

Visually Induced Dizziness Secondary Effects

- Disorientation
- General Discomfort
- Postural Instability
- Restricted Head Movement
- Excessive Fatigue
- Brain Fog
- Agoraphobia
- Anxiety

Worsening Vestibular Symptoms



With thanks to Amy Lennox, Hypatia

Visual vertigo rehab

- VR to sensory reweight
  - Down weight the visual system
  - Upweight contributions from proprioception and make best use of residual vestibular function (exercises with eyes closed and different surfaces)
  - Can be relatively straight forwards, or can be more complex, depending on underlying pathology and associated symptoms such as avoidance and anxiety
  - Caution for VM, PPPD and post concussive dizziness…. Slowly slowly

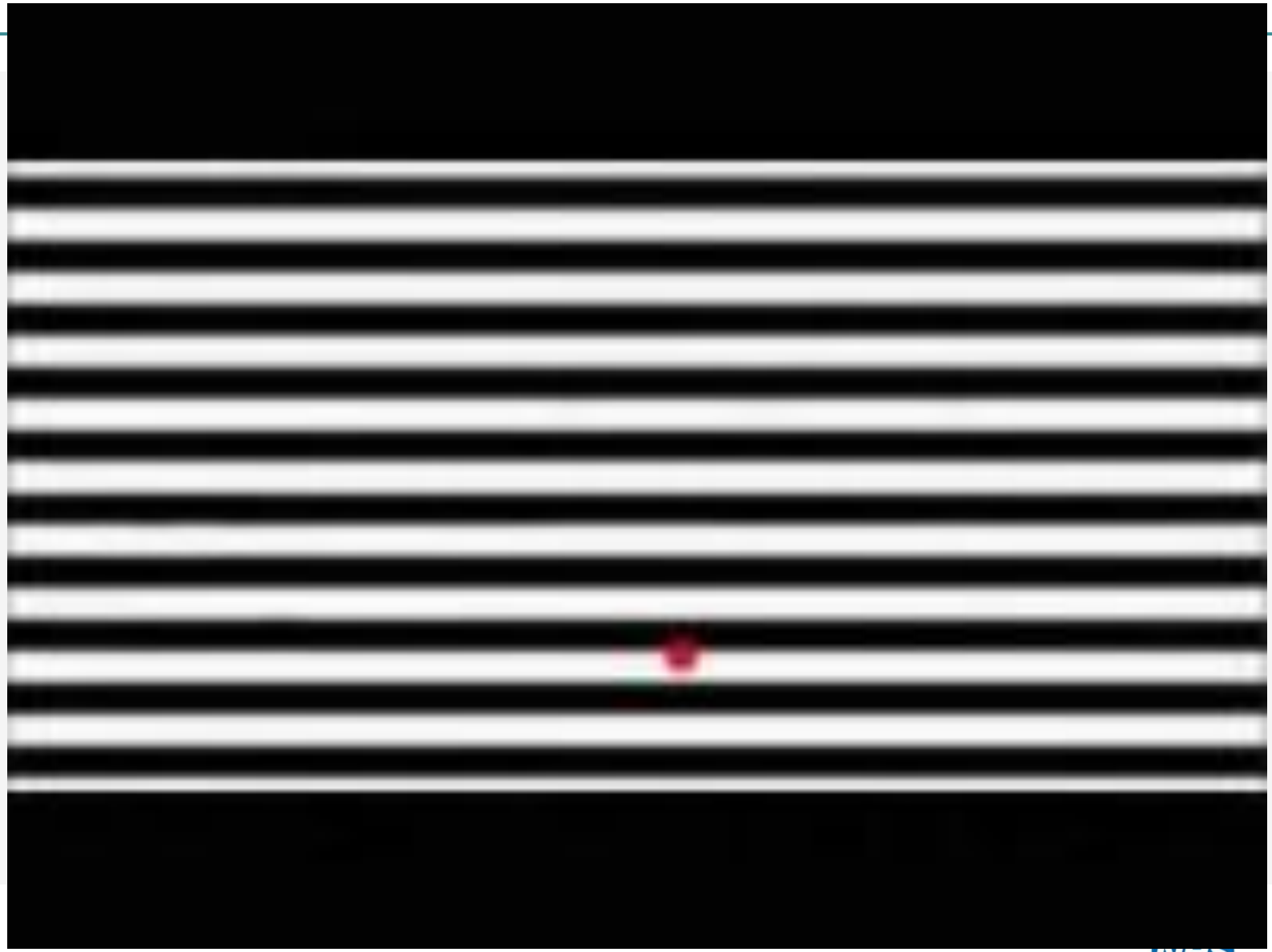
https://www.youtube.com/watch?v=v8O0xzD6Ax0 what is visual vertigo?

Home visual vertigo/desensitization exercises

- X1 with spotty/ stripy background
- Scrolling up and down word document
- Spinning spotty/stripy umbrella
- Head shake/nod with moving background (eg screen saver)
- Watching action DVD (still or with head movements
- Playing computer games (screen comes out)
- Walking in progressively challenging places

Graded! Ensure any migraine under control

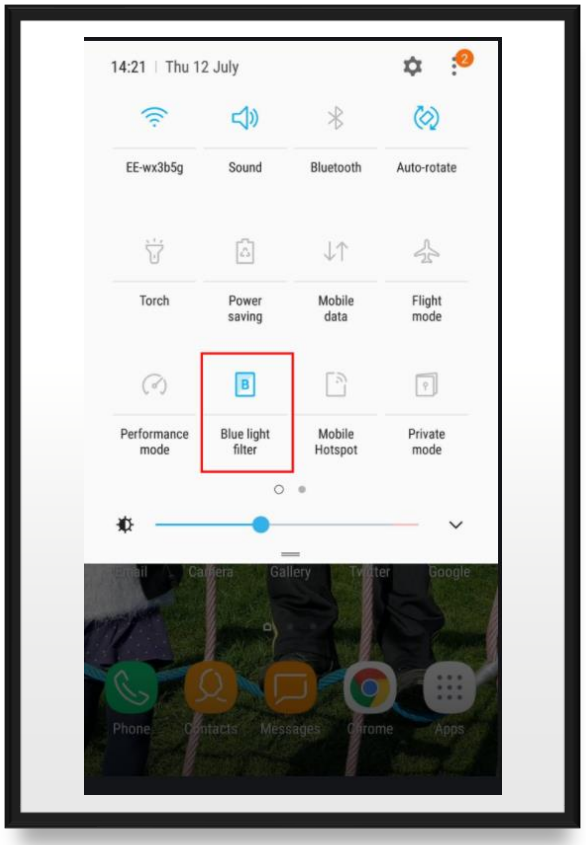
Optokinetic videos ** see end (from 5 mins)

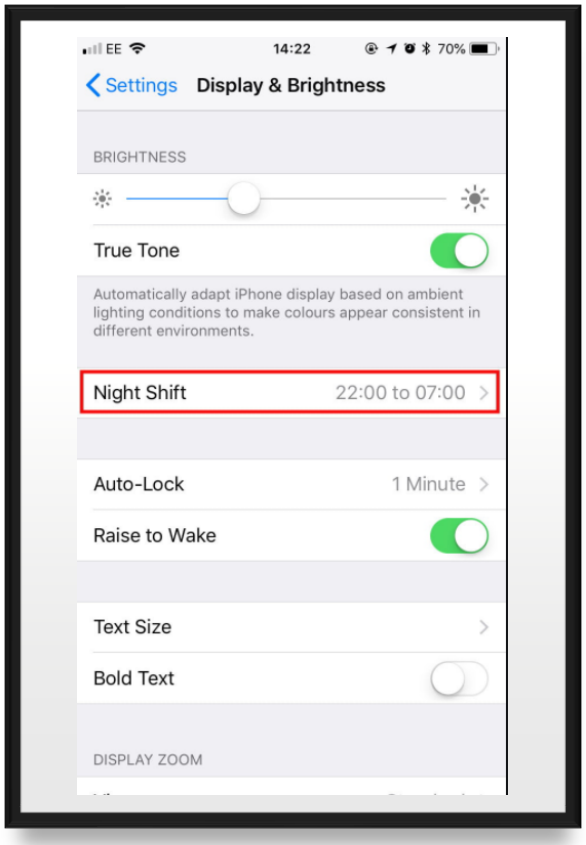


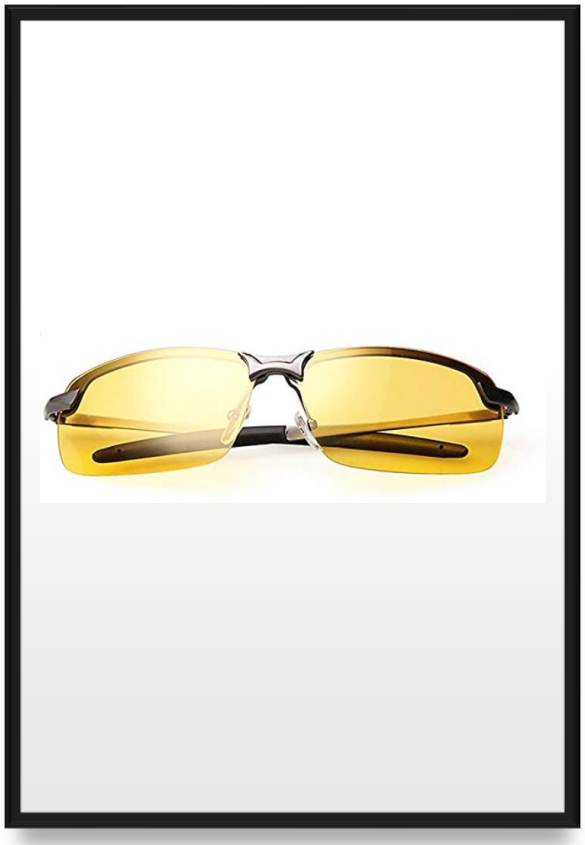
https://www.youtube.com/watch?v=kAPtu1WTHYc&list=PLm5WqOZTtywHLW7gIHajtOSm0_R2cHKF

Disco ball


Red Green Blue Purple
Upgraded Version 4 Colours
LED
STOP START
1 Music
2 Music
3 Music
Flash
R
G
B
P
GP
RB
AUTO
LED REMOTE







With thanks to Amy Lennox, Hypatia

‘Clinical pearls’ Pavlou Vr conference 2018

CLINICAL PEARLS

- Do not introduce OKS too early! The first session in clinic may be too early and overwhelming which could lead to a negative outcome.
- Screen size matters, a cell phone is too small. An iPad or laptop is a more ideal screen size. A full immersive surround is also unnecessary.
- Visual motion videos exist on You Tube: walking, driving, running, rollercoasters, and optokinetic stripes allow for flexibility and variety.
- Vary the distance to the screen from near to far.
- Progress from sitting to standing to walking, without then with head motions.
- Give specific instructions on “how to watch” the OKS: Start with “stare through the motion,” progress to target fixation, scanning, saccades, or X1 viewing.
- Gradually progress exposure and exercise complexity!

Pavlou: intensity and duration

- 2 minute bouts of okn stimulation with 1 or more minutes of rest
- Starting with 4 exercises and increasing by 2 additional exercises each week
- Start much more slowly with migraineurs, stabismus and convergence insufficiency (15 s)

Thanks to Amy Lennox
For more come to Hypatia Gold!

Virtual Reality Rehabilitation

- Controlled Stimulus
- Can slowly increase difficultly
- Can isolate visual exercise or provide complex sensory integration exercises.
- Take away proprioceptors
- Take away vestibular inputs

- Patient is in control
- Can't fall if seated
- Increases confidence

- Can be completed at home
- Can be managed in a telemedicine environment
- Can co-inside with traditional VOR rehabilitation.

Hot off the press! Meta analysis https://link.springer.com/article/10.1007/s00405-023-07911-3

Virtual reality for visual vertigo (thanks to Amy Lennox)

- On boarding: outcome measures + patient voiced, snow walk
- *Graded* approach to desensitization: 5-10 mins
  - **Videos causing dizziness/discomfort/nausea at 6 /10**
  - Oculus VR goggles and visually stimulating videos

https://youtu.be/a_oqcg0hvpo

https://www.youtube.com/watch?v=7AkbUfZjS5k
Starts with waterfall then lake, then beach
stop, esc, esc, move slide on manually, from current slide

https://www.youtube.com/watch?v=ZDZ4oF4VrHI
Beach

Virtual reality with or without goggles

Bilateral hypofunction/complete loss of function

- Oscillopsia
  - Visual blurring or jumping with head movement due to poor or no VOR
- Postural instability: particular difficulty if vision or proprioception also compromised
- Not uncommon to report constant low level dizziness

- Remaining vestibular function determines degree and speed of recovery
- Severe/complete loss may not be able to drive and be limited in sports/dancing

Oscillopsia

https://www.youtube.com/watch?v=fsD3RDUqgJU
https://www.youtube.com/shorts/TQ8fX5BMJQw (walking)
https://www.youtube.com/watch?v=skhZT_KHaKo (car)

Exercises

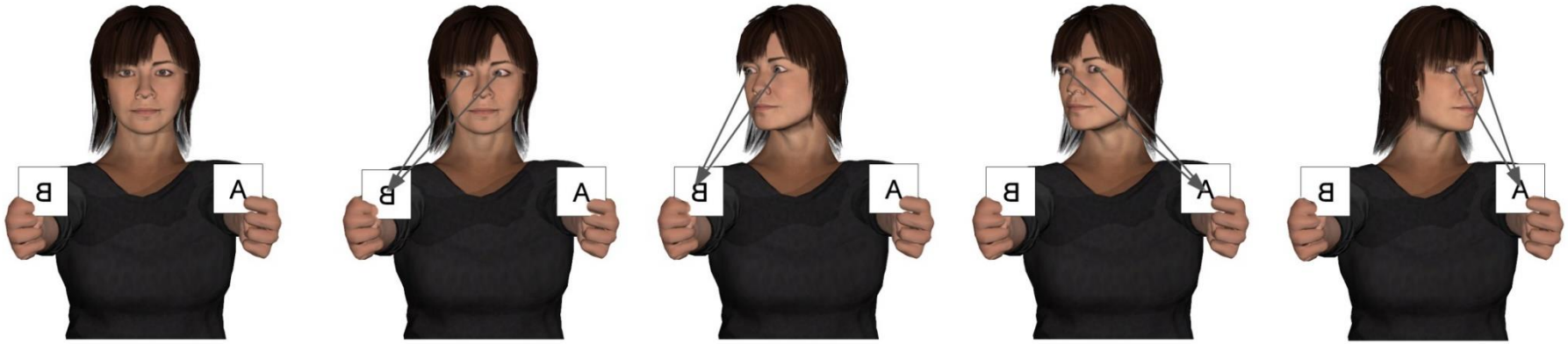
- Same philosophies apply
  - importance of setting appropriate goals and expectations
  - Outcome will depend on degree of loss and take longer

- Postural stability and own strategies
  - Encourage patients to develop own strategies
  - Use of a walking aid
  - Standing and walking exercises
  - Encourage the patient to move so that can develop their own strategies to feel *safe and in control*

Exercises (2)

- Encourage adaptation if residual function
- Development of pre programmed saccades and use of other visual strategies
  - Gaze shifting (active eye head movements)
  - Remembered targets
- *?could these latter 2 help unilateral hypofunction?*

Gaze shifting



- Similar exercises to UVL: gaze stabilization, standing and walking… made easier for standing and walking, may not need habituation
- Also additional central pre-programming exercises- try and encourage pre-programmed saccades to gaze stabilise

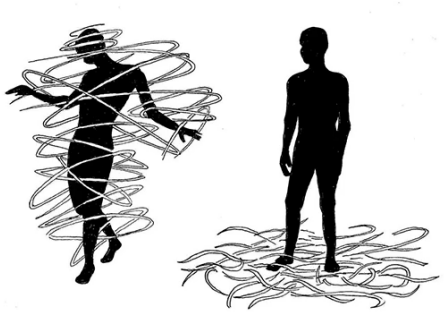
Remembered targets

Remembered targets

Balance Retraining Exercises

Gaze Stabilization: Remembered targets horizontal

Please listen to the safety information video before you start your balance exercise plan



British Society of Audiology
Promoting excellence in hearing and balance

Ménière's Society
for dizziness and balance problems

MANCHESTER 1824
The University of Manchester

Manchester University NHS Foundation Trust

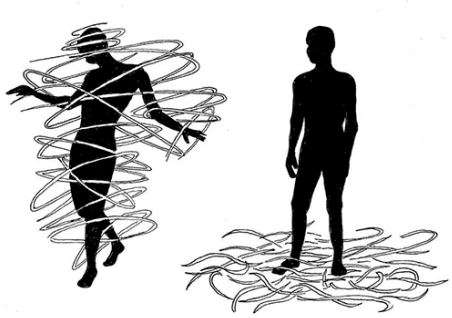
HYPATIA TRAINING

Gaze shifting

Balance Retraining Exercises

Gaze Stabilization: Gaze shifting horizontal

Please listen to the safety information video before you start your balance exercise plan



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NHS
Manchester University
NHS Foundation Trust

HYPATIA
TRAINING

Substitution: use of saccades,?COR and ? smooth pursuit

- Cervical ocular reflex
  - COR gain in normals 0.07-0.2 and dynamic range < 0.1Hz
  - In bilateral loss gain can in increase to 0.8 at 0.1 Hz and DR to 0.2-0.4 Hz
  - *This 10 x less than normal head movements therefore no large contribution*

- Smooth pursuit
  - Gain of SP in BVL at upper end of normal, but doesnt exceed normal peak velocity and frequency (1Hz) and *likely not large contribution*

Hope for BVL where limited gain increase

- Dynamic visual acuity often improved more than gain increase would suggest
  - ? Another central mechanism causing gaze stability (other than increase in gain)

- Oscillopsia and reported handicap
  - Not always dependent on gain/DVA increase: can be improved by balance and gait exercises
  - Tolerance to retinal slip and patients *feeling of control over their health* (Grunfield at al 2000)

BVL and other symptoms

- *Patients with vestibular disorder complain of a loss of memory and attentional focus, visual spatial memory/orientation difficulties*

- Vestibular input to hippocampus, parietal cortex and many other areas
  - Contribution to higher cortical (cognitive) functions eg spatial memory and orientation, multisensory motion perception, and navigation

http://www.neuropt.org/special-interest-groups/vestibular-rehabilitation/podcasts
Implication of vestibular input to the hippocampus on vestibular rehabilitation

Elderly patients

- Age related degenerative changes can affect all the vestibular system
- Cerebral small vessel disease (next slide)
- Progressive bilateral loss of function?

- Incidence of BPPV increases with age

- Ability to compensate less good (if had previous vestibular insult)

- Multifactorial dysequlibrium of aging and other medical causes of dizziness

Changes in the central vestibular system
(See references by Kaski and Ibitoye)

- **Cerebral small vessel disease/ cortical/cerebellar atrophy**
- Often present with **unexplained dizziness** as peripheral findings normal (WMH on mri)

- Disorder of vestibular and postural **processing/ integration** due to disconnectivity (in various areas)
- **Mismatch** between intended motor action (efferent) and sensory input (afferent) becomes conscious
- Csvd mediated **dysregulation of cerebral BP-** intracerebral hypoperfusion standing and walking

  - ↑neural resources needed for postural control (even in asymptomatic patients)
  - Different neuronal circuits used in dizzy patient (compared to normal elderly and young) as measured by postural sway and EEG Ibitoye 2021

Elderly Patients

- History
  - Of balance problems
  - Falls – how many, circumstance, injury/loc
  - Risk factors for falls
  - Remember Hearing!
  - Visual/proprioceptive problems
  - Other medical problems and medication

- Appropriate testing

VR Exercises for elderly

- *DONT CREATE FALLS RISK! Work within your remit and refer when necessary*
- Treat BPPV first if present

- Tailored, supervised, not creating falls risk
  - Gaze stabilization exercises, head movement exercises sitting down
  - Standing balance, walking exercises
  - Long loop reflexes, Lower limb strengthening exercises

- Encourage keeping generally active
- Falls prevention advice or referral to falls prevention clinic- Nice guidelines https://www.nice.org.uk/guidance/qs86

Telehealth and VR ?

- Remote/attend anywhere?
- VRT/Epleys
  - Is this safe?
  - What is patient preference

- Research booklet based approach to be clinically and cost effective (RCT) (van Vugt et al. *BMJ*. 2019;367:l5922)
  - Nurse administered (with telephone support)
  - Self administered (with and without telephone support)
  - **Web based version** https://balanceretraininghs.lifeguidewebsites.org

http://www.neuropt.org/special-interest-groups/vestibular-rehabilitation/podcasts Telehealth in VR

Apps: Vertigenius http://www.vertigenius.com/

- Assessment
  1. Balance Tests.
  2. Dynamic Visual Acuity.
  3. Gait Speed.

  Can also be used as outcome measure

- Balance Exercises
  - Gait Exercises
  - Gaze Stabilisation Exercises
  - Habituation Exercises
  - Cervical Proprioception Exercise
  - Optokinetic Exercises
  - Vergence Exercises
  - Strengthening Exercises

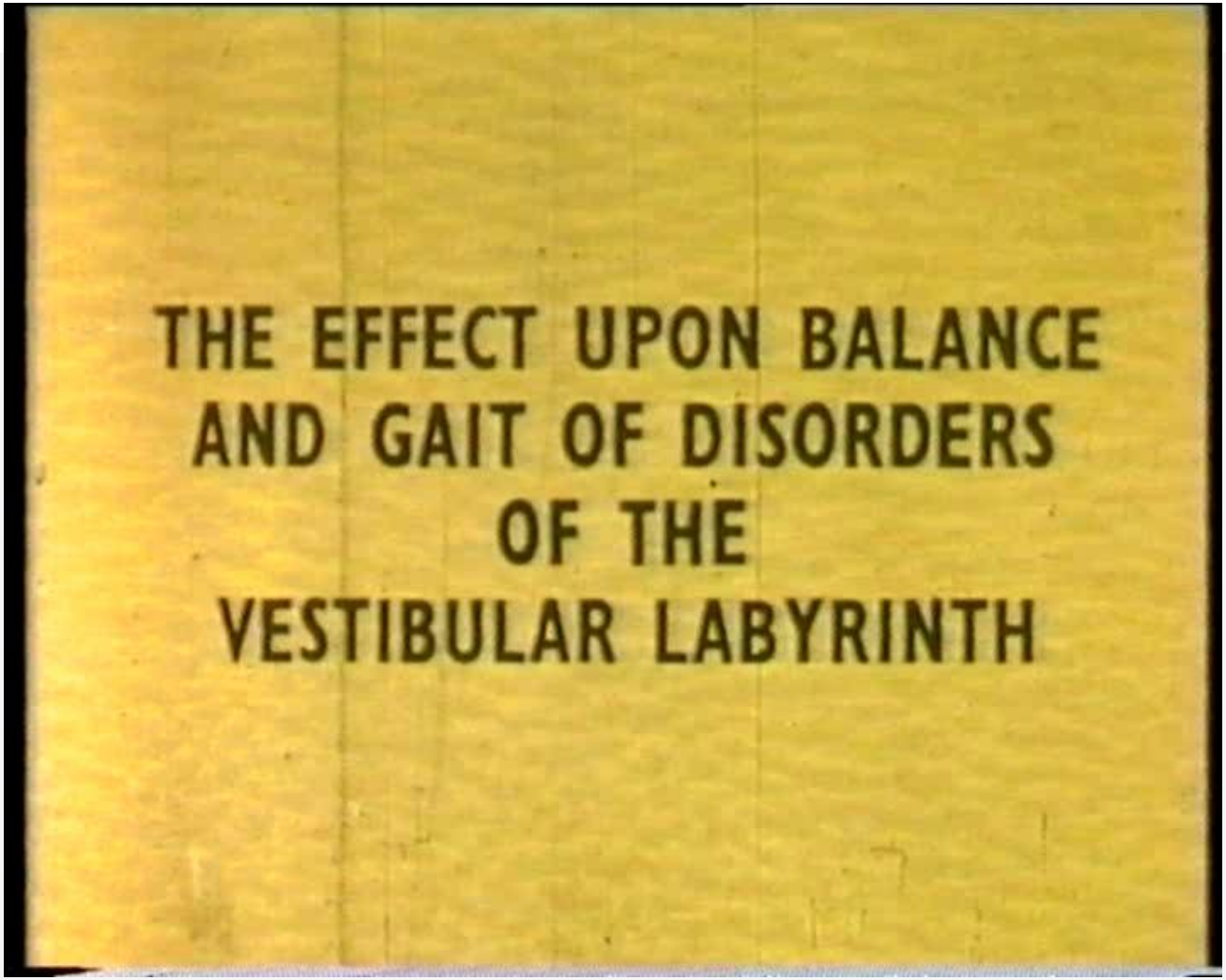
- 'Plan sent to patient
- Head senor to track head movements:
- Monitor and guide patient remotely'


What about the goldfish?

Compensation in gold fish after unilateral utriculus and scc removal. Ott et al 1988

2. The period of several minutes following the operation was characterized by severe postural asymmetry and locomotor ataxia. In the operated fish, but not the sham-operated ones, the eyes rolled tonically towards the operated side without nystagmus, the body was flexed towards the operated side, and any swimming was disoriented with rolling motion towards the operated side. These deficits lasted less than 30 min after revival from the anaesthesia. All three behavioural deficits ended abruptly within 1 min of each other for individual fish, and normal, nearly upright swimming was then maintained, even in the dark.

3. We interpret this recovery as one of the first stages in the central process of vestibular compensation. The unusually abrupt end of these deficits in adult goldfish compared with that in other vertebrates suggests a remarkable capacity for the central nervous system to adapt. The speed of recovery of three distinct motor outputs supports models of early compensation that utilize central modulation or gain control of existing pathways, rather than anatomical reorganization.

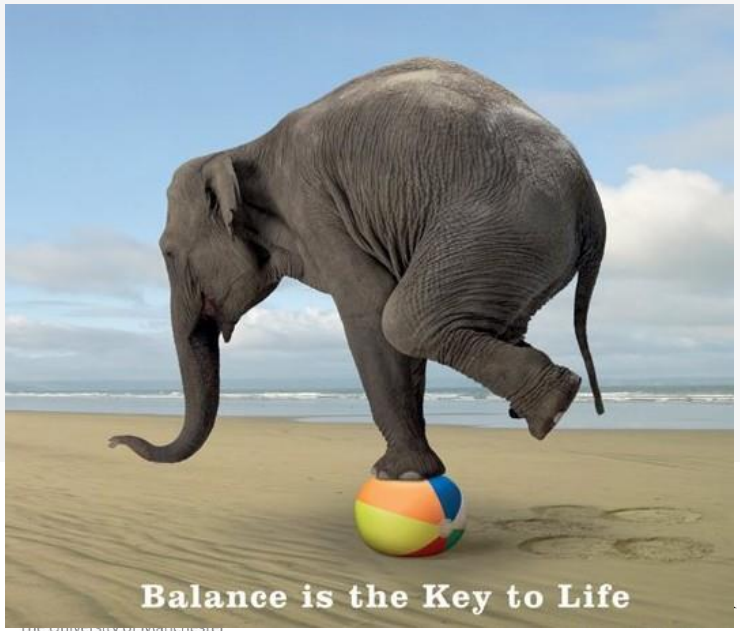


Old footage from Queens Square Neuro-otology

Take home messages?

- So go forth and rehabilitate!!

- Basic VR is not rocket science or expensive!
- However it can get complicated..
- Work within your remit and seek advice where needed



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References and resources

- Hall et al Practice Guideline J Neurol Phys Ther 2022 Apr 1;46(2):118-177. Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Updated Clinical Practice Guideline From the Academy of Neurologic Physical Therapy of the American Physical Therapy Association
- Geraghty A et al. (2017) Internet-Based Vestibular Rehabilitation for Older Adults With Chronic Dizziness: A Randomized Controlled Trial in Primary Care. *Annals of Family Medicine,* 15 , 209-16
- Han, B. I., Song, H. S., & Kimc, J. S. (2011). Vestibular Rehabilitation Therapy: Review of Indications, Mechanisms, and Key Exercises. *J Clin Neurol*, *7*, 184-196.
- Jiao Y, Lin Y, Zhang X, Wu Y, Wang J, Liang Z. *Lin Chung Er Bi Yan Hou Tou Jing Wai Ke Za Zhi*. 2020;34(5):447-451. doi:10.13201j.issn.2096-7993.2020.05.015 / (virtual reality study)
- Klatt, B. N., Carender, W. J., Lin, C. C., Alsubaie, S. F., Kinnaird, C. R., Sienko, K. H., & Whitney, S. L. (2015). A conceptual framework for the progression of balance exercises in persons with balance and vestibular disorders. *Physical medicine and rehabilitation international*, *2*(4).
- MacDougall, H. G., & Curthoys, I. S. (2012). Plasticity during vestibular compensation: the role of saccades. *Frontiers in neurology*, *3*, 21.
- McDonnell, M. N., & Hillier, S. L. (2015). Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. *The Cochrane Library*.
- Whitney S et al (2016) Recent Evidence About the Effectiveness of Vestibular Rehabilitation. *Curr Treat Options Neurol* 18, 13
- Yardley, L., Barker, F., Muller, I., Turner, D., Kirby, S., Mullee, M., et al, (2012). Clinical and cost effectiveness of booklet based vestibular rehabilitation for chronic dizziness in primary care: single blind, parallel group, pragmatic, randomised controlled trial. *BMJ*, *344*, e2237.

Overall summary from updated guidelines 2022

- **‘VR recommendation increases from moderate to strong**
- **Supervised VPT** promotes adherence and continued participation in VR exercises and may lead to improved outcomes

- **Cognitive impairment or moderate to severe mobility dysfunction** may lead to attrition if unsupervised, potentially leading to **limited improvement**

- **No studies** specifically examine frequency, duration, or exercise intensity as factors that influence treatment efficacy for individuals **with BVH.** Nevertheless, it is possible to make some preliminary suggestions about exercise dose based on the clinical experience of the GDG and compilation of evidence from several studies.

- **Gaze stab and dose:**
  - Clinicians may prescribe weekly clinic visits plus an HEP of GSE consisting of a minimum of:
  - 3 times per day for a total of at least 12 minutes daily for individuals with acute/subacute UVH
  - 3 to 5 times per day for at least 20 minutes daily for 4 to 6 weeks for individuals with chronic UVH
  - 3 to 5 times per day for a total of 20 to 40 minutes daily for approximately 5 to 7 weeks for individuals with BVH ‘

Vestibular rehabilitation for peripheral vestibular hypofunction: An *updated* clinical practice guideline (2022)

- ***'New evidence from 18 randomized clinical/controlled trials (RCTs), 9 prospective and 8 retrospective cohort studies***
- Expanded action statement profiles to explicitly state quality improvement opportunities, intentional vagueness, and implementation and audit
- New evidence in support of **earlier initiation** of VPT, **within the first 2 weeks** of acute onset of UVH
- Support for consideration of a **variety of balance training modalities**, including low technology, virtual reality, optokinetic stimulation, platform perturbations, and vibrotactile feedback
- New recommendations regarding **balance exercise dosage** (intensity, duration, or frequency) for individuals with chronic UVH and BVH
- Stronger recommendation supporting the **decision to stop therapy** with specific considerations in making the decision to stop therapy based on results from 24 new studies
- Expanded recommendations on **factors that may impact rehabilitation outcomes**, including the effects **of medications and mild cognitive impairment'**

Vestibular rehabilitation for peripheral vestibular hypofunction: An *updated* clinical practice guideline (2022)

- There is **strong evidence** that vestibular physical therapy (VPT) provides a **clear and substantial benefit** to individuals with unilateral (UVH) and bilateral vestibular hypofunction (BVH)

- With the exception of extenuating circumstances, VPT should be offered to individuals, especially those older than 50 years, who are experiencing **signs (unsteadiness, near-falls, or falls) or symptoms (dizziness, disequilibrium, motion sensitivity, and/or oscillopsia) of vestibular hypofunction**

- For **the majority** of individuals, VPT results in **improved** *balance, reduced symptom complaints, improved functional recovery including activities of daily living, reduced fall risk, and improved quality of life*

- There is **some evidence** that dynamic postural stability as well as quality of life for individuals with **BVH does not improve to the same extent** as for individuals with UVH.

VR for PVH: An *updated* clinical practice guideline (2022) Outcome measures

TABLE 6. Patient-Reported Outcome Measures for Individuals With Vestibular Hypofunction

MEASURE	WHAT IT MEASURES
Activities-specific Balance Confidence Scale	Confidence in balance without falling or being unsteady across a continuum of activities[49,50]
Balance Exercise Difficulty Scale	Self-report rating of the perceived intensity of balance exercises[51]
Disability Rating Scale	Level of disability based on descriptions of symptoms and limited activities[24]
Dizziness Handicap Inventory	Perceived handicap as a result of dizziness[52]
Hospital Anxiety and Depression Scale	A 14-item scale to identify anxiety and depression among ill patients (the Hospital Anxiety and Depression Scale)[53,54]
Oscillopsia Functional Impact scale	Impact of oscillopsia on daily activities[55]
Oscillopsia Severity Questionnaire	Severity of oscillopsia during various activities[56]
Positive Affect Negative Affect	Validated and reliable tool for assessing depression and anxiety in individuals with dizziness[57]
UCLA Dizziness Questionnaire	Severity, frequency, and fear of dizziness and its effect on quality of life and activities of daily living[58]
Vertigo Handicap Questionnaire	Effects of vertigo on disability, handicap, and psychological distress[59]
Vertigo Symptom Scale	Quantifies number and frequency of symptoms of vertigo, autonomic sensations and anxiety arousal, and somatization[25]
Vestibular Activities and Participation	Effect of dizziness and/or balance problems on ability to perform activity and participation tasks according the ICF WHO document[60]
Vestibular Disorders Activities of Daily Living Scale	Independence in everyday activities of daily living[61]
Vestibular Rehabilitation Benefit Questionnaire	Impact of symptoms on quality of life[62.63]
Visual Analog Scale	Perceived level of symptom (eg, disequilibrium, dizziness, or oscillopsia)[21,64]
Visual Vertigo Analog Scale	Rates the intensity of visual vertigo for challenging situations of visual motions that may provoke dizziness [23]

Visual vertigo videos

- **Darius Rejalil** with moonlight sonata !! 10 mins of delightfulness ☺
- https://www.youtube.com/watch?v=kAPtu1WTHYc&list=PLm5WqOZTtyvwHLW7glHaJtOSh0_R2cHKF

- **Gabrielle Pierce OK training**
- https://www.youtube.com/channel/UCwDX4UUxFH7BZhs2gFYw6oA
- a channel with lots of optokinetic training videos in lots of different scenarios: supermarkets, hotel corridors with patterned carpets, driving etc.

- Or look under optokinetic on you tube

You tube virtual reality channel with oculus/other goggles

- https://vr.youtube.com/watch/: about
- https://www.youtube.com/channel/UCzuqhhs6NWbgTzMuM09WKDQ: channel

- VR 360º with compass icon in the upper left of a video
- https://www.youtube.com/watch?v=ZDZ4oF4VrHI Beach