What do I need to know about multisensory interactions?

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Cortex: Conscious Perception
Vertigo

Brainstem: III/IV/VI nerves - VOR
Nystagmus & Oscillopsia

Brainstem - Autonomic centres
Nausea, Sweating, Heart Pounding

Spinal: Vestibular Spinal Tract
Unsteadiness
The Components of the Balance System

Three inputs:
- Vestibular
- Visual
- Proprioceptive
  (+ cognition)

Four outputs:
- Conscious perception
- Eye movements
- Body movements
- Autonomic (visceral)
An example of Vestibulo-Proprioceptive interaction:

The COR
An example of ‘proprioceptive – cognitive’ interaction: Context dependent modulation of the COR
Visual interactions in balance control

- Visuo-vestibular interaction
- Visuo-proprioceptive interaction (postural)
- Visual input in vestibular compensation
  - Visual dependency
Visuo-Vestibular interaction:

1\textsuperscript{st}: VOR + OKN
2\textsuperscript{nd}: VOR Suppression
Visual input for the suppression of **ocular** instability (nystagmus)

7 days post op.  R labyrinthectomy

Fixation ↑ Darkness

right

left
Visual input for the suppression of postural instability
Fixating on an object in the foreground (parallax) can reverse the direction of visuo-postural sway - no trivial ‘reflex’!
Eye-in-head and head-on-trunk position is taken into account a function of ocular and cervical proprioceptors?

Cognitive control: Action & Expectation
The concept of short and long latency loops

Head-drop technique for vestibulo-spinal reflexes
‘Head drop technique’

- **Passive drop**: ‘relax and let the head fall’
- **Active drop**: ‘relax but stop the drop as soon as you can’
Normal head drop

R SCM, EMG

Acceleration traces

Active
Passive

0.5 g

1 mV

Time (ms)

The Motor System and its Multiple Levels

Birnbaumer 1991
Vestibular compensation

7 days post op. R labyrinthectomy

Fixation ↑ Darkness

28 days post op.
Factors delaying vestibular compensation

- Fluctuating vestibular disorder
- Additional disorder:
  - CNS
  - Peripheral nerve
  - Cervical spine
  - Visual
- Lack of mobility
- Drugs
- Psychosocial
- Visual dependence
The Concept of VISUAL DEPENDENCE in the normal population

Witkin 1959
Peripheral Vestibular Symptoms

- Vertigo and nausea
- Dizziness
- Motion intolerance:
  - Head motion
  - Visual motion
Peripheral Vestibular Symptoms

- Vertigo and nausea
- Dizziness
- Motion intolerance:
  - Head motion
  - Visual motion → VISUAL VERTIGO
Dizziness worsened by visual stimulation

- **One of the ‘Underrated neuro-otological symptoms’**
  (Hoffman and Brookler 1978).
- ‘**Motorist's vestibular disorientation syndrome**’
  (Page and Gresty 1985).
- ‘**Space and motion discomfort**’
  (Jacob et al 1993).
- ‘**Visual vertigo syndrome**’
  (Bronstein 1995).
- ‘**Visual vestibular mismatch**’
  (Longridge et al 2002).
Visually disorienting surroundings:

- Supermarkets, repetitive fences
- Ironing striped shirts, drawing curtains
- Disco lights, movies
- Traffic, driving, crowds
- Flowing rivers, clouds

...beware of panic attacks, agoraphobia and psychosomatic dizziness
Visual Vertigo Patients
Postural Tests: static and dynamic visual stimuli

Fastrack

Force plate
Stabilising and Destabilising effects of Vision

![Graph showing the quotient for Normal controls, Visual Vertigo, and LDS for EC / EO and Disk / EO. The graph indicates differences in the quotient values between the groups.]
Optokinetic treatment

Optokinetic disc


Optokinetic drum

Eyetrek
Do I need posturography to see which patients have visual dependence?

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NO! Talking to your patients is actually better

Computerised Dynamic Posturography
What do I need to know about multisensory interactions?

- Balance is a function of the brain, not the ear
- The brain uses all possible sensory resources available for balance
- Even the simplest head or body movements involve multiple sensory inputs
- Any input may be missing or ‘unreliable’, both in health and disease but the brain will continue to balance you by means of:
  ---> sensory reweighting
  ---> central compensation
- These processes are, to some extent, idiosyncratic (vary from person to person)
- As clinicians we must be aware of these issues when treating our patients
  → this is the basis of good, customised rehabilitation