

VESTIBULAR REHABILITATION: General principles and Practical Applications

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December 1st*

KOLKATA
(India)

WHY IS IT NECESSARY TO MANAGE VERTIGO AND DIZZY PATIENTS ?

**1. Because there is a high prevalence
of vestibular dysfunctions in the general
population**

HIGH PREVALENCE OF VESTIBULAR DYSFUNCTIONS

ORIGINAL INVESTIGATION

Disorders of Balance and Vestibular Function in US Adults

Data From the National Health and Nutrition Examination Survey, 2001-2004

Yuri Agrawal, MD; John P. Carey, MD; Charles C. Della Santina, MD, PhD; Michael C. Schubert, PhD; Lloyd B. Minor, MD

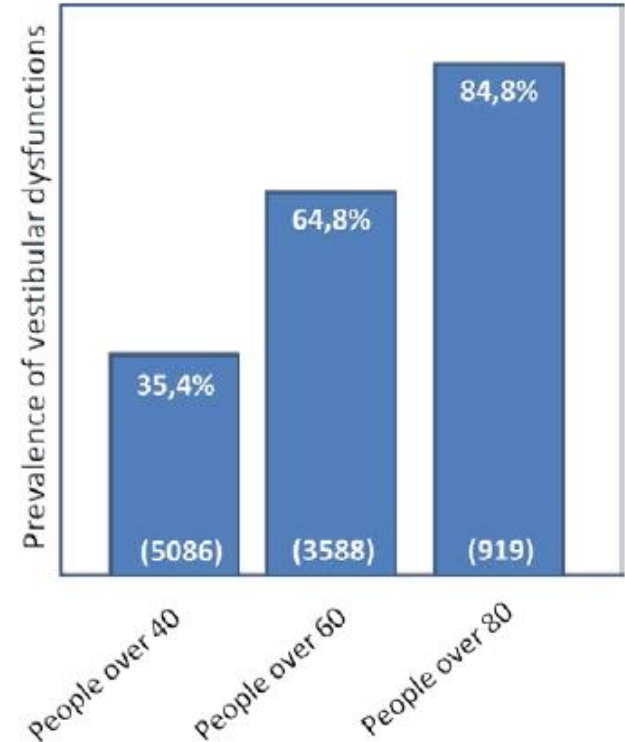
Background: Balance dysfunction can be debilitating and can lead to catastrophic outcomes such as falls. The inner ear vestibular system is an important contributor to balance control. However, to our knowledge, the prevalence of vestibular dysfunction in the United States and the magnitude of the increased risk of falling associated with vestibular dysfunction have never been estimated. The objective of this study was to determine the prevalence of vestibular dysfunction among US adults, evaluate differences by sociodemographic characteristics, and estimate the association between vestibular dysfunction and risk of falls.

Methods: We included data from the 2001-2004 National Health and Nutrition Examination Surveys, which were cross-sectional surveys of US adults aged 40 years and older (n=5086). The main outcome measure was vestibular function as measured by the modified Romberg Test of Standing Balance on Firm and Compliant Support Surfaces.

Results: From 2001 through 2004, 35.4% of US adults aged 40 years and older (69 million Americans) had vestibular dysfunction. Odds of vestibular dysfunction increased significantly with age, were 40.3% lower in individuals with more than a high school education, and were 70.0% higher among people with diabetes mellitus. Participants with vestibular dysfunction who were clinically symptomatic (ie, reported dizziness) had a 12-fold increase in the odds of falling.

Conclusions: Vestibular dysfunction, as measured by a simple postural metric, is common among US adults. Vestibular dysfunction significantly increases the likelihood of falls, which are among the most morbid and costly health conditions affecting older individuals. These data suggest the importance of diagnosing, treating, and potentially screening for vestibular deficits to reduce the burden of fall-related injuries and deaths in the United States.

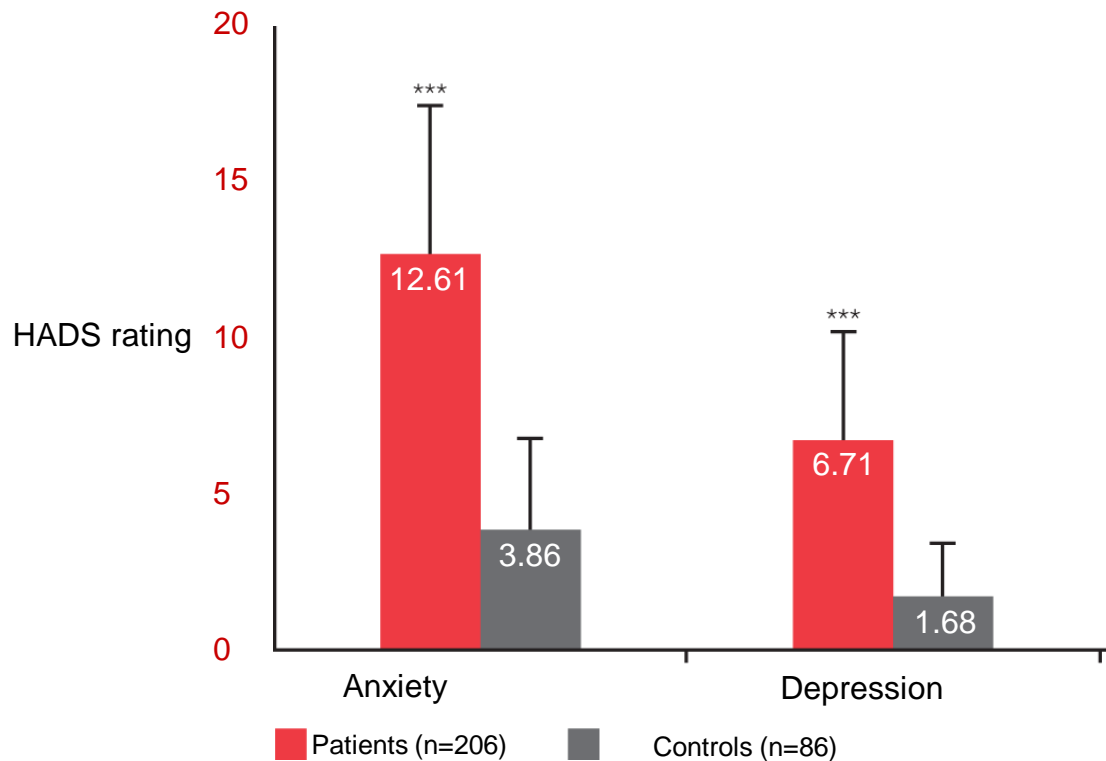
Arch Intern Med. 2009;169(10):938-944



WHY IS IT NECESSARY TO MANAGE VERTIGO AND DIZZY PATIENTS ?

**2. Because of the strong negative impact
of vertigo and dizziness
on the quality of life**

ANXIETY AND DEPRESSION IN VERTIGO PATIENTS



TOTAL SCORES MEASURED BY THE HOSPITAL ANXIETY AND DEPRESSION SCALE (HADS) ARE SIGNIFICANTLY INCREASED IN PATIENTS WITH VERTIGO

WHY IS-IT NECESSARY TO MANAGE VERTIGO AND DIZZINESS ?

3. For three other reasons

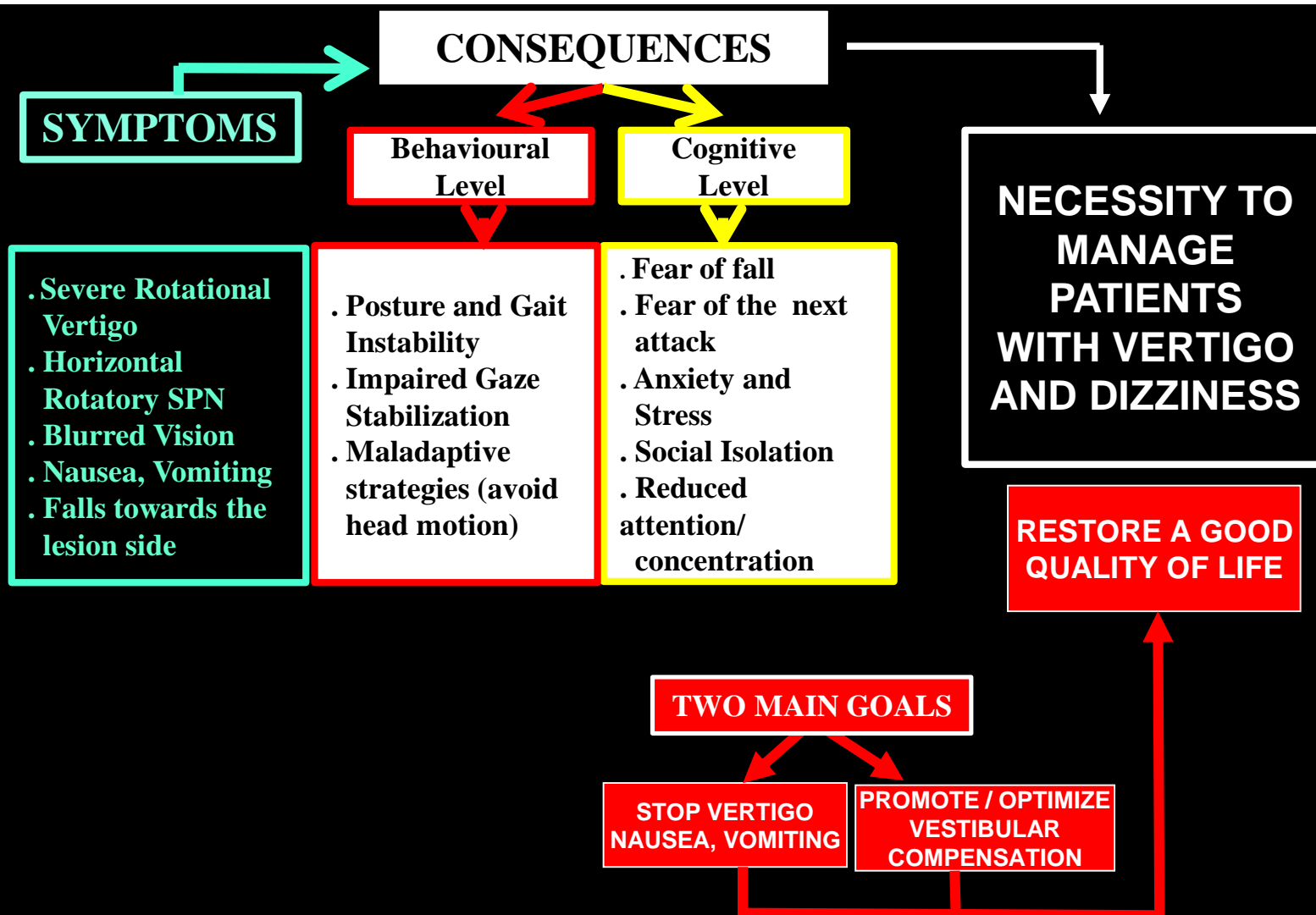
Vestibular Compensation: The neuro-otologist's best friend

Lacour M, Helmchen C, Vidal PP, J Neurol (2015)

**There is a Spontaneous Compensation of Vestibular Functions,
BUT:**

- 1. The time constant is long (6 months)**
- 2. The compensation is not optimal in many cases**
- 3. There is sometimes some discrepancy between the objective recovery and the self-evaluation by the patients (quality of life)**

MANAGEMENT OF PATIENTS WITH UNILATERAL VESTIBULAR DEFICITS



MAIN GOAL OF VESTIBULAR REHAB

→ **IMPROVE AND OPTIMIZE THE
VESTIBULAR COMPENSATION PROCESS**

VESTIBULAR REHABILITATION

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graph TD; A[VESTIBULAR REHABILITATION] --> B[. RESTORE GAZE STABILITY  
. RESTORE POSTURE STABILITY AND BALANCE  
. RESTORE COGNITIVE DEFICITS  
. RESTORE PERCEPTIVE DEFICITS  
. RESTORE A GOOD QUALITY OF LIFE]; A --> C[DEPENDS ON  
- Pathology  
- Age  
- Psychologic profile  
- Professional Activity  
- etc ...];
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- . RESTORE GAZE STABILITY
- . RESTORE POSTURE STABILITY AND BALANCE
- . RESTORE COGNITIVE DEFICITS
- . RESTORE PERCEPTIVE DEFICITS
- . RESTORE A GOOD QUALITY OF LIFE

- DEPENDS ON**
- Pathology
 - Age
 - Psychologic profile
 - Professional Activity
 - etc ...

IS VESTIBULAR REHABILITATION THERAPY SAFE AND EFFECTIVE ?

YES

Cochran Database of Systematic Reviews (Hillier & McDonnell, 2007)

« **There is a moderate to strong evidence that vestibular rehabilitation is a safe, effective management for unilateral peripheral vestibular dysfunction, based on a number of high quality randomized controlled trials** »

Cochran Database of Systematic Reviews (Hillier & McDonnell, 2011)

Confirmation of these conclusions

MANY PRINCIPLES ARE REQUIRED FOR OPTIMAL VESTIBULAR FUNCTION RECOVERY

Interaction between vestibular compensation mechanisms and vestibular rehabilitation therapy: 10 recommendations for optimal functional recovery

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Frontiers in Neurology 5:285. doi: 10.3389/fneur.2014.00285

1. **Do VR Actively**
2. **Do VR Early**
3. Favor Adaptation Processes
4. No stereotyped VR
5. Take into account the Sensorimotor/Cognitive profile of the patients
6. **VR therapy guides the plasticity mechanisms (instructive role)**
7. **Reduce anxiety and stress**
8. Use a Top-Down Progression
9. Use Ecologic contexts
10. **Motivate the patients**

IMPLICATIONS FOR VR

KEY CONCEPT 1

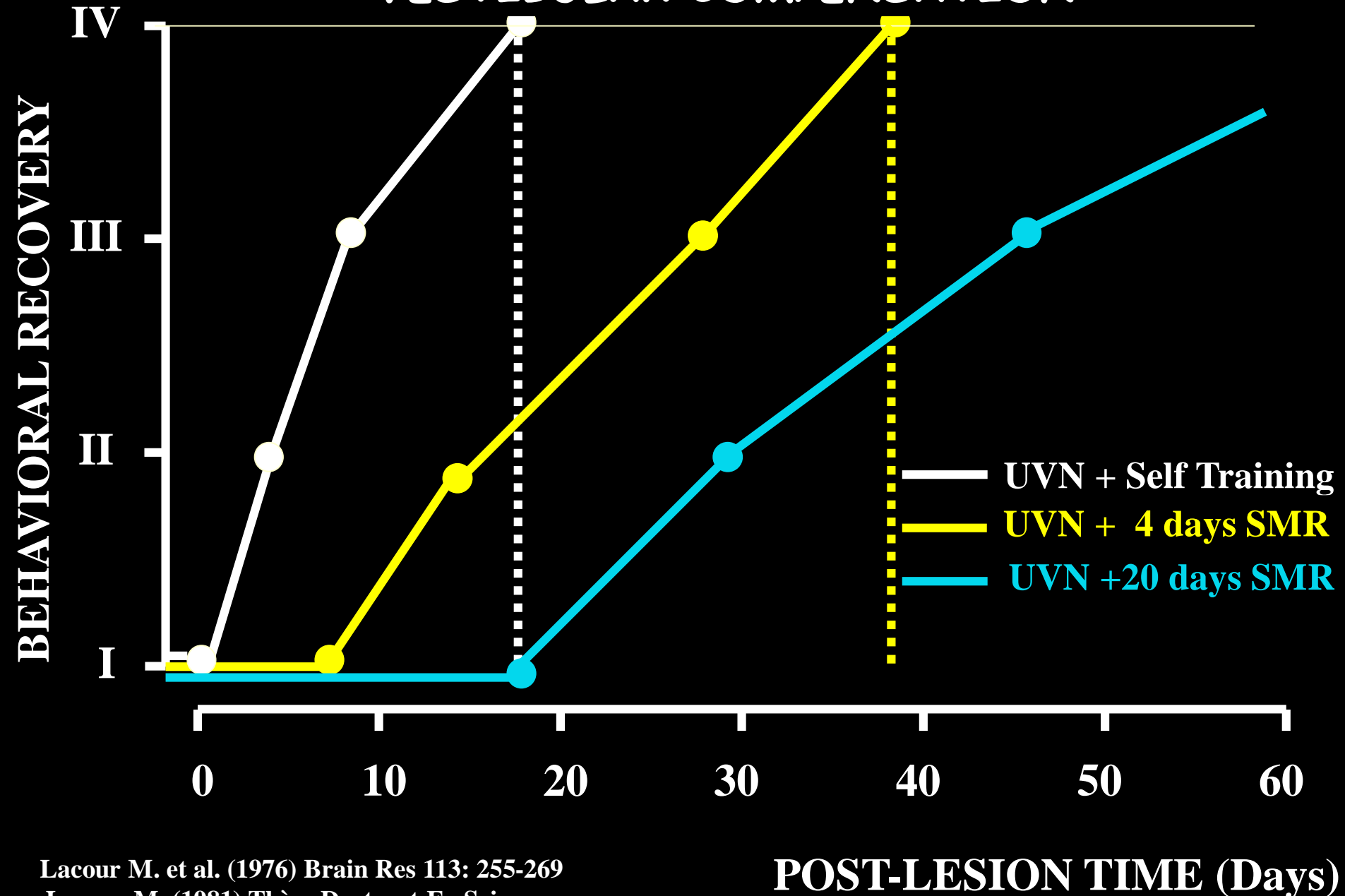


The brain reorganizations after vestibular deficits are neural-activity dependent:

Neuronal Reorganizations are Favored and Reshaped by Sensorimotor Activity

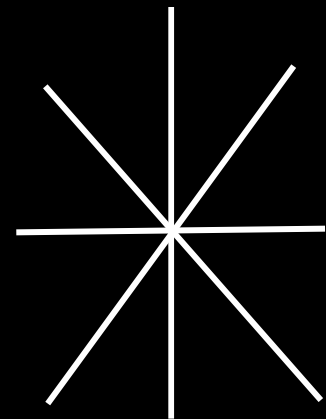
« Use your Neural Plasticity or Lose it ! »

ACTIVE RETRAINING PROMOTES VESTIBULAR COMPENSATION



IMPLICATIONS FOR VR

Kitten Visual Cortex



After Normal
Postnatal
Visual Experience



After Postnatal
Visual Experience
of Verticality only

KEY CONCEPT 2



Hubel et Wiesel, 1975

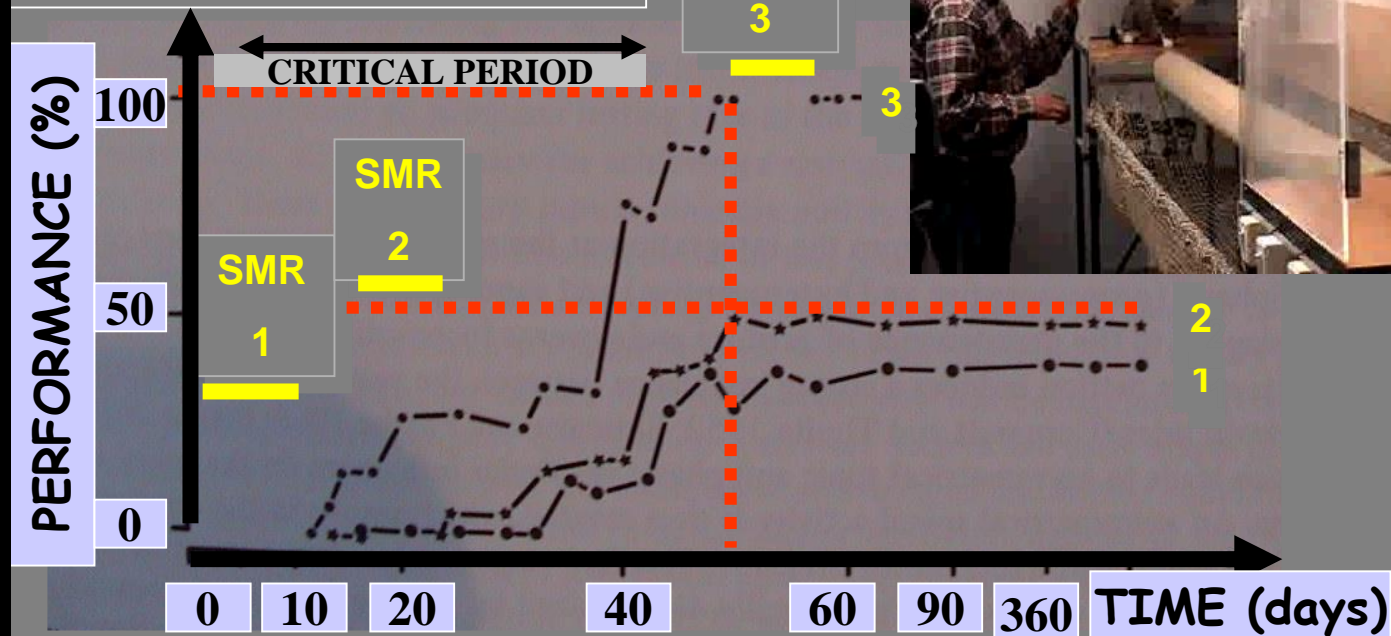
The brain reorganizations after vestibular deficits are
Postlesion time-dependent

Functional brain remodelings are favored by the plasticity mechanisms expressed early after an acute vestibular loss. The best recovery is observed if training/rehabilitation is done during this opportunity window or sensitive period.

« Earlier is better for Vestibular Rehabilitation ? »

AN EARLY RETRAINING LEADS TO THE BEST FUNCTIONAL RECOVERY

SMR=Sensorimotor restriction (1 week)
mimicking in the cat the behaviour
of a patient resting in his bed for 8 days



(Lacour et al., 1976 – Monkey)

(Lacour et Xerri, 1981 – Cat)

RESEARCH RECOMMENDATIONS (2017)

Summary of Research Recommendations (American Physical Therapy Association).

R. Research Recommendation 1: Researchers should examine the concept of a **critical period** for optimal vestibular compensation through studies that examine early versus delayed intervention. Researchers should identify factors that predict which patients will recover without the benefit of vestibular rehabilitation and which patients will need vestibular rehabilitation to optimize outcomes.

R. Research Recommendation 4: There is sufficient evidence that vestibular exercises compared with no or placebo exercises are effective; thus, future research efforts should be directed to **comparative effectiveness research**. Researchers should directly compare different types of vestibular exercise in large clinical trials to determine optimal exercise approaches

R. Research Recommendation 6: Researchers should examine the **impact of frequency, intensity, time, and type of exercises** on rehabilitation outcomes. Researchers should determine the difficulty of exercises and how to progress patients in a systematic manner.

R. Research Recommendation 7: Researchers should determine **optimal duration** of vestibular rehabilitation for favorable outcomes and the factors that impact functional recovery.

R. Research Recommendation 9: Researchers should examine the **concept of return to work**. Areas for study include job requirements that may be difficult for patients with vestibular hypofunction, job modification, or assistive technology to allow return to work, criteria for return to work or disability assignment, indicators for return to safe driving.

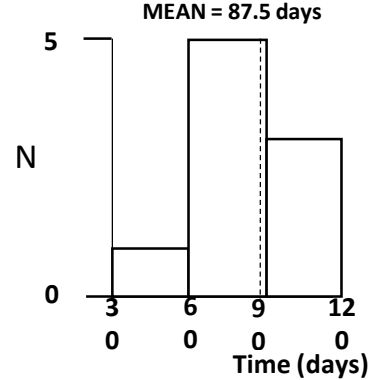
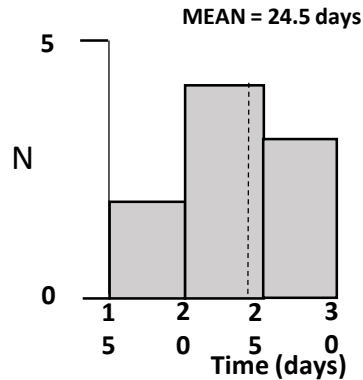
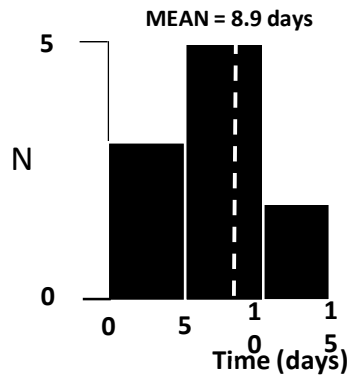
A

DYNAMIC VISUAL ACUITY	DIRECTIONAL PREEPONDERANCE	Angular VOR GAIN	COVERT SACCADES	DHI SCORE
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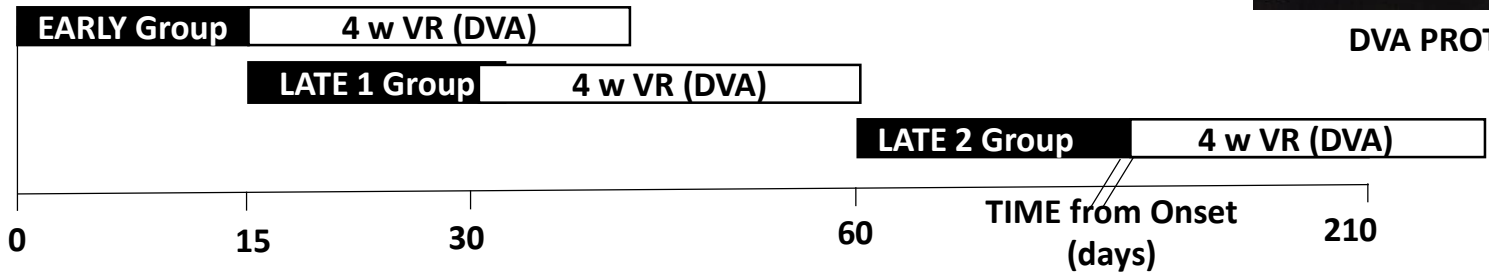
EARLY DVA REHAB
(<15 days)
N = 10

LATE 1 DVA REHAB
(>15 days < 30 days)
N = 9

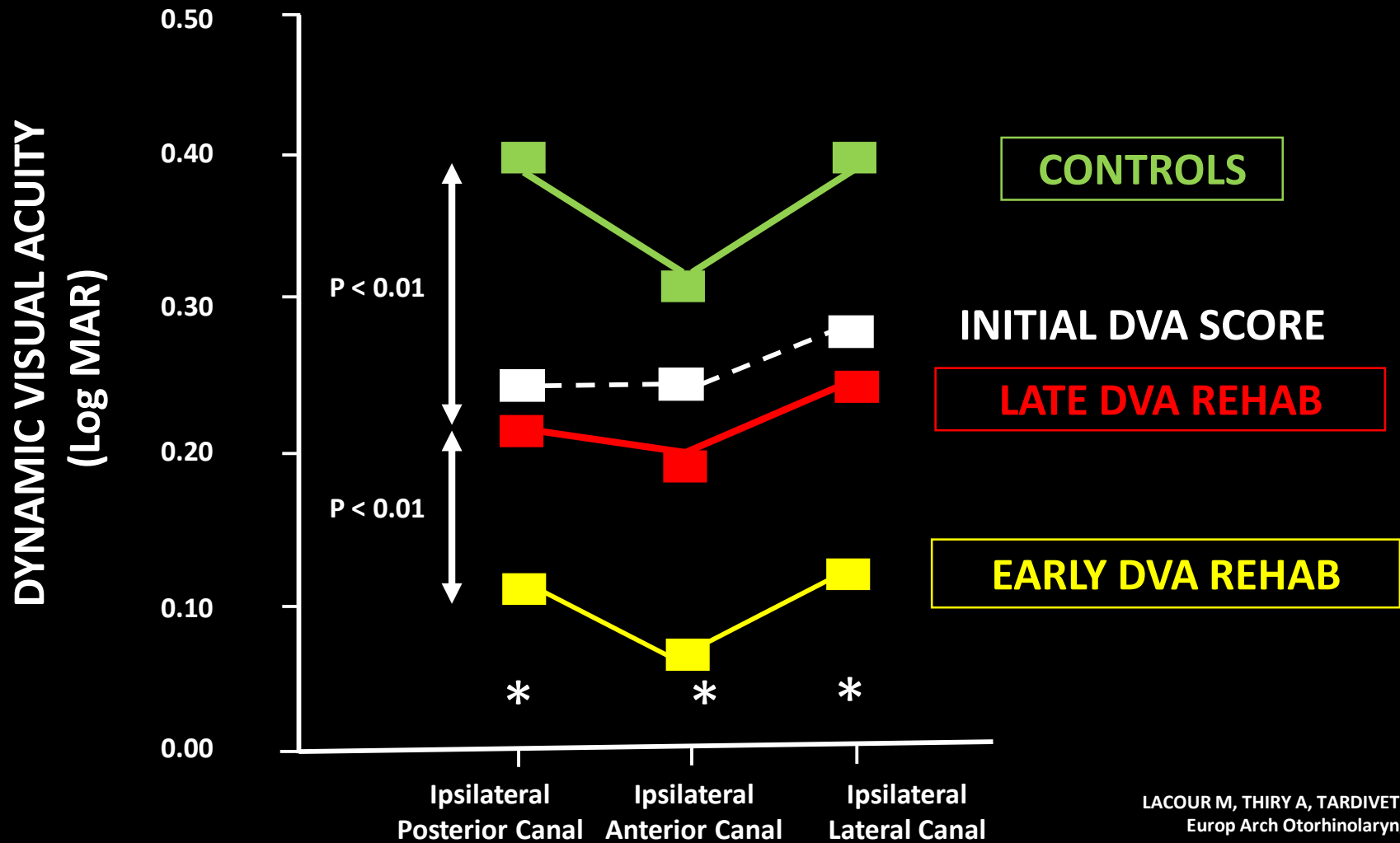
LATE 2 DVA REHAB
(>1 month)
N = 9



DVA PROTOCOL

B

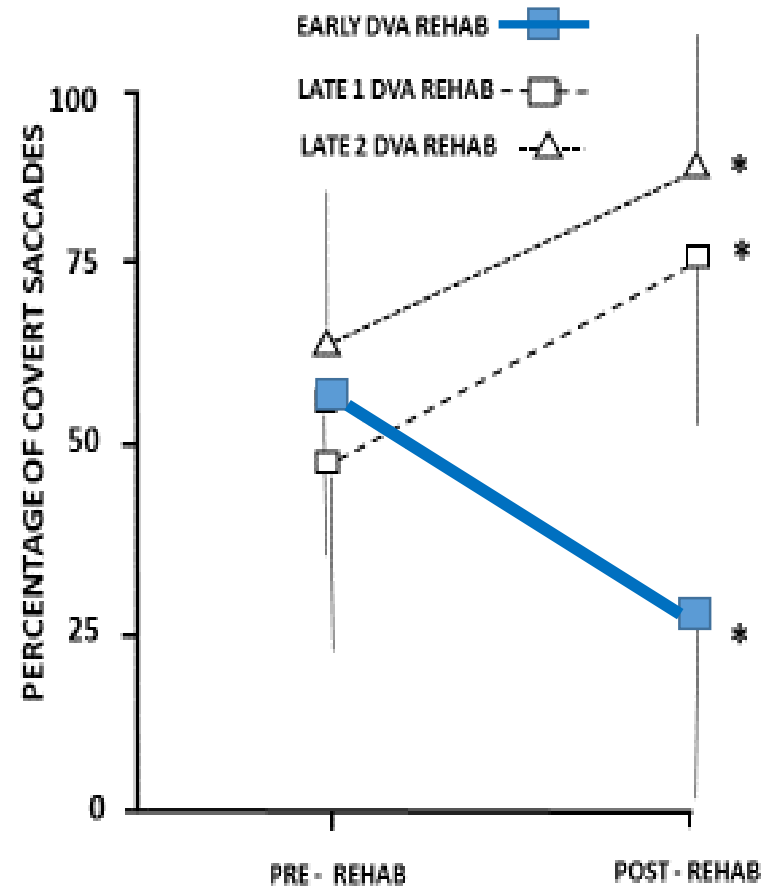
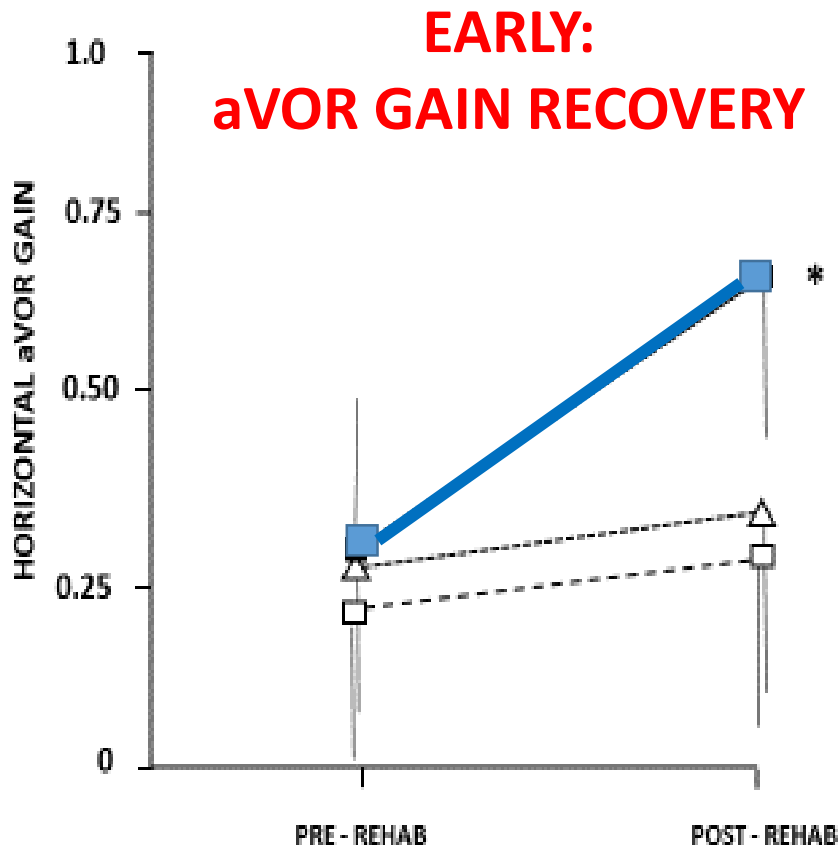
NORMAL DVA IS RESTORED AFTER EARLY REHAB, NOT AFTER LATE REHAB



LACOUR M, THIRY A, TARDIVET L (2019)
Europ Arch Otorhinolaryngol

DIFFERENT RECOVERY MECHANISMS DEPENDING ON WHEN VESTIBULAR REHAB IS STARTED

LATE: COVERT SACCADES



Lacour, Tardivet, Thiry (2019) Eur Arch Otorhinolaryngol

CRITICAL POSTLESION TIME PERIOD or Opportunity Window

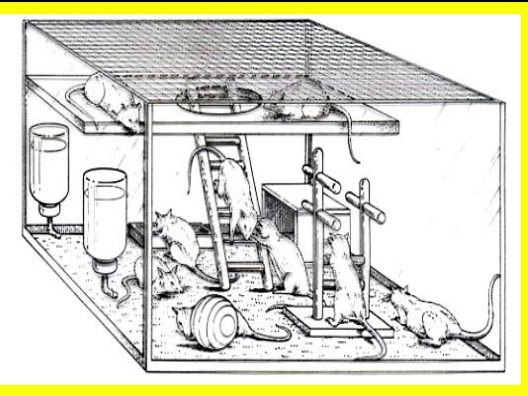
ACUTE PERIPHERAL UNILATERAL VESTIBULAR PATHOLOGY



**EFFICACY OF VESTIBULAR REHAB ON DYNAMIC VISUAL ACUITY
AND DIRECTIONAL PREPONDERANCE**

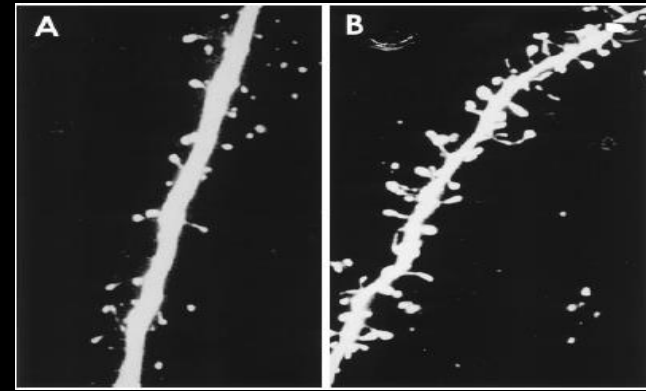
**AN EARLY VESTIBULAR REHAB LEADS TO OPTIMAL FUNCTIONAL
RECOVERY (faster)
AND LESS EXPENSIVE HEALTH COSTS (less vestibular rehab sessions)**

IMPLICATIONS FOR VR



Hebb (1950)

KEY CONCEPT 3

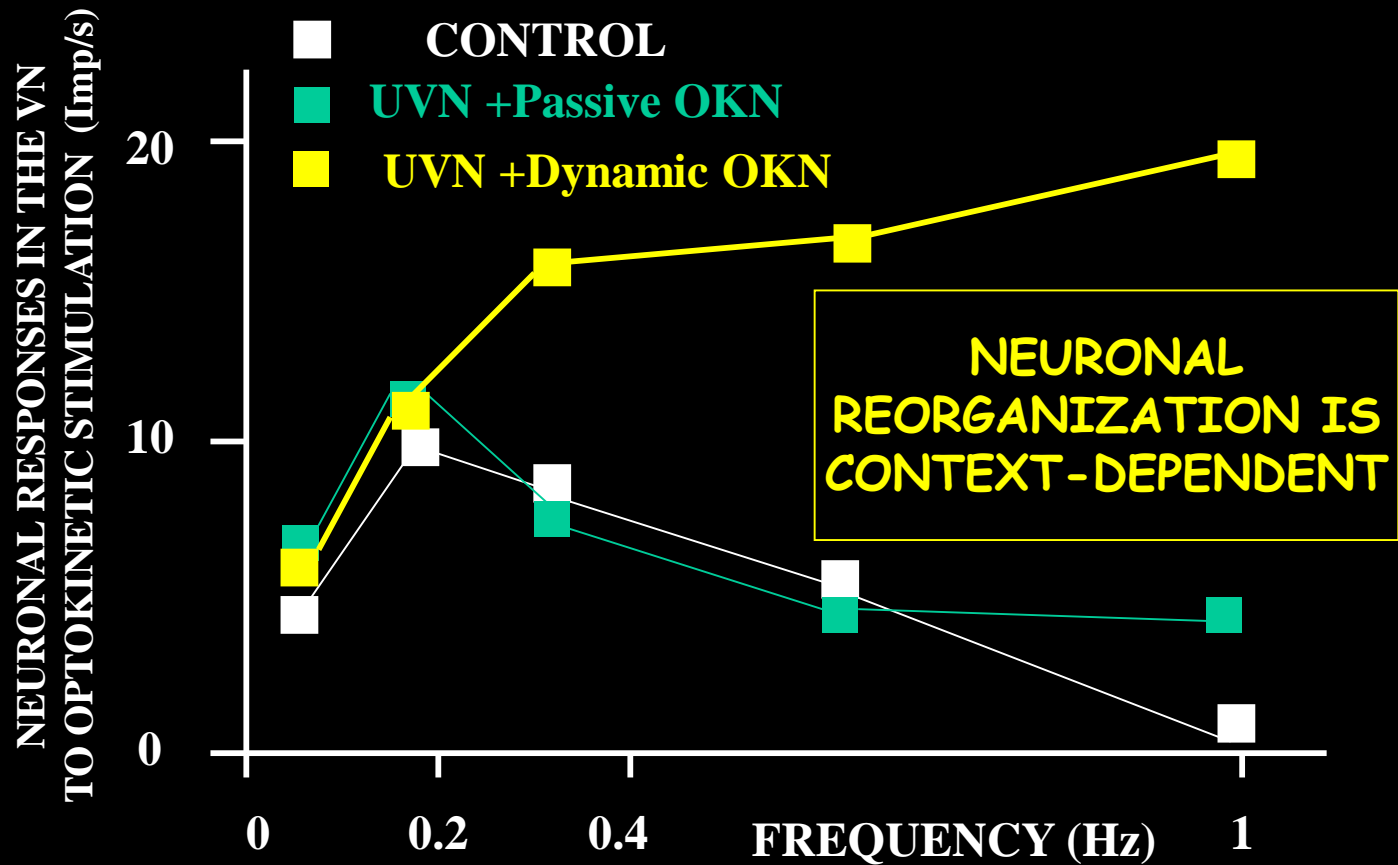


Kempermann et al. 1998

Different rehabilitation programs induce different brain re-organizations/changes in the brain functional connectivity

« Vestibular Rehabilitation Guides the Brain Remodelings ? »

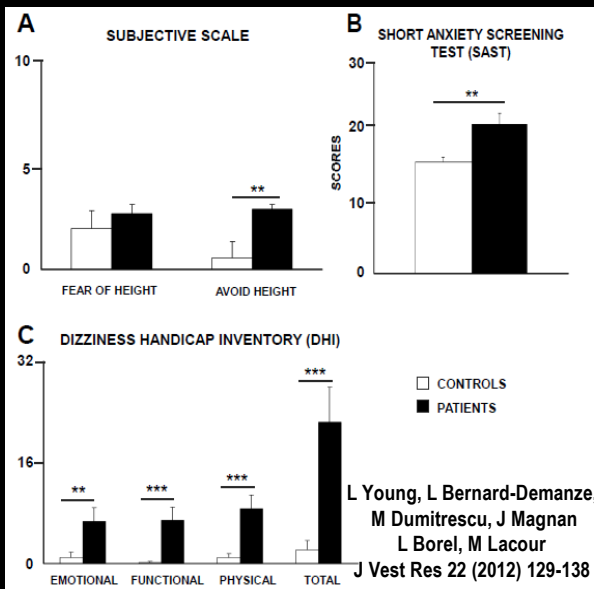
POSTLESION EXPERIENCE RESHAPES THE NEURONAL PROPERTIES IN A CONTEXT-DEPENDENT WAY



Zennou-Azogui et al., Beh Brain Res (1996)

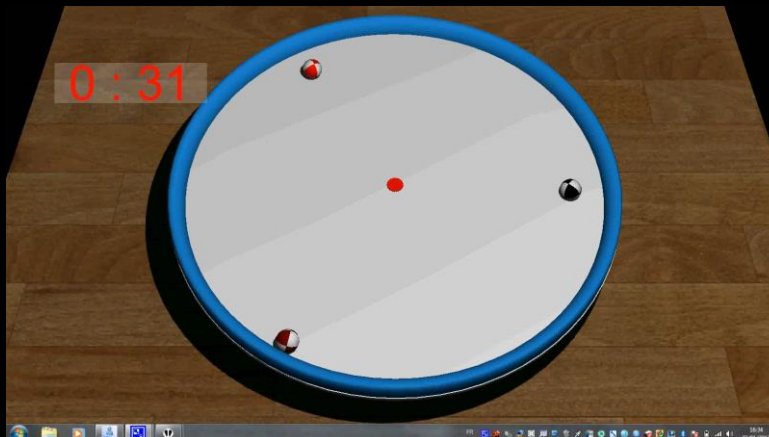
IMPLICATIONS FOR VR

KEY CONCEPT 4



Vestibular loss induces both behavioural and cognitive deficits, increases patients' anxiety and stress, and may lead to low motivation

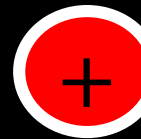
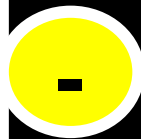
« Vestibular Rehabilitation must fight these psychologic/
affective factors: cognitive training (and virtual reality) may help »



REHABILITATION
(Intensity, Duration,
Exercises Progression,
Variety)

REWEIGHTING OF SENSORY CUES
BEHAVIOURAL STRATEGIES
UPDATING OF THE INTERNAL MODELS

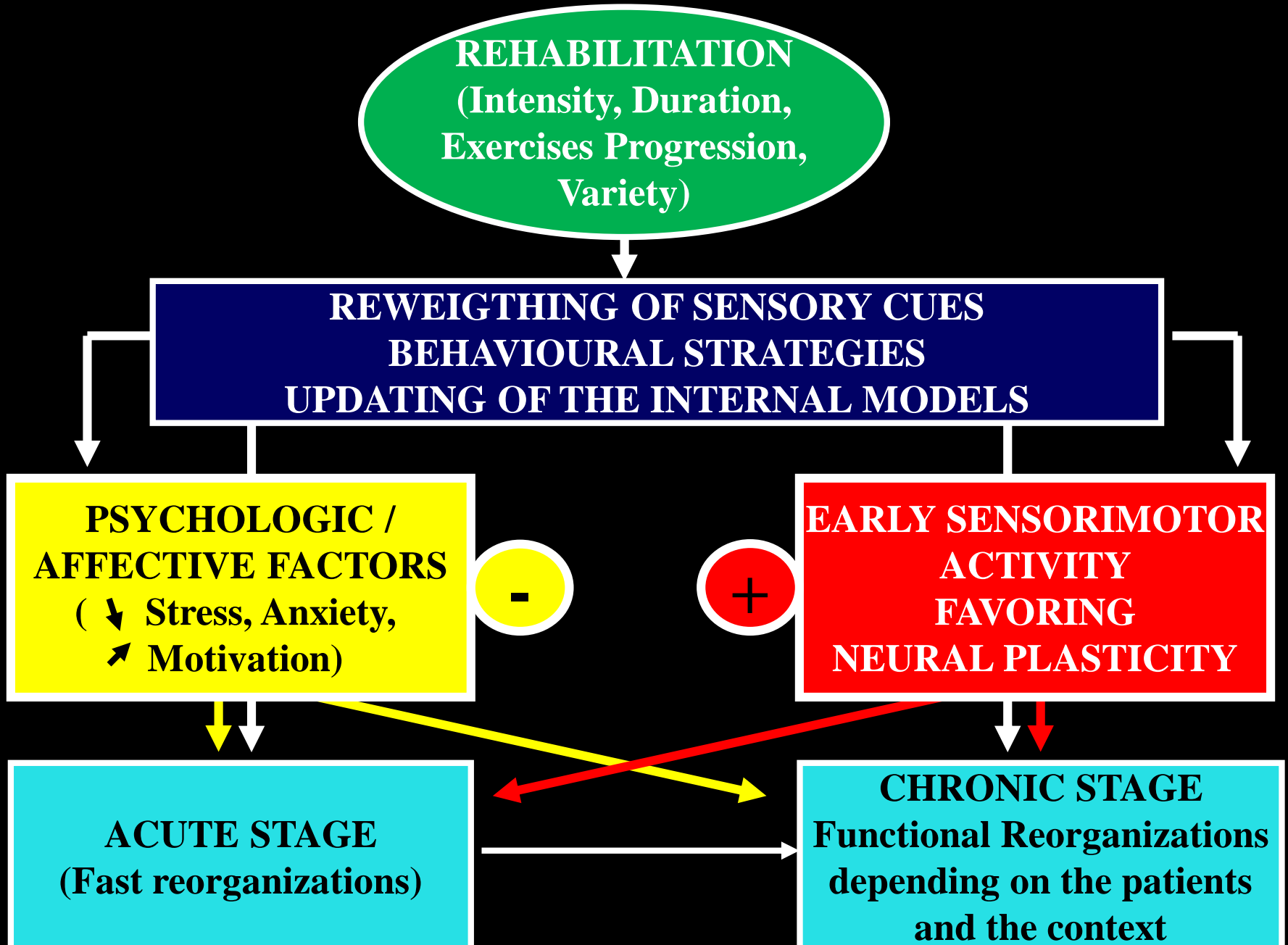
**PSYCHOLOGIC /
AFFECTIVE FACTORS**
(↓ Stress, Anxiety,
 ↗ Motivation)



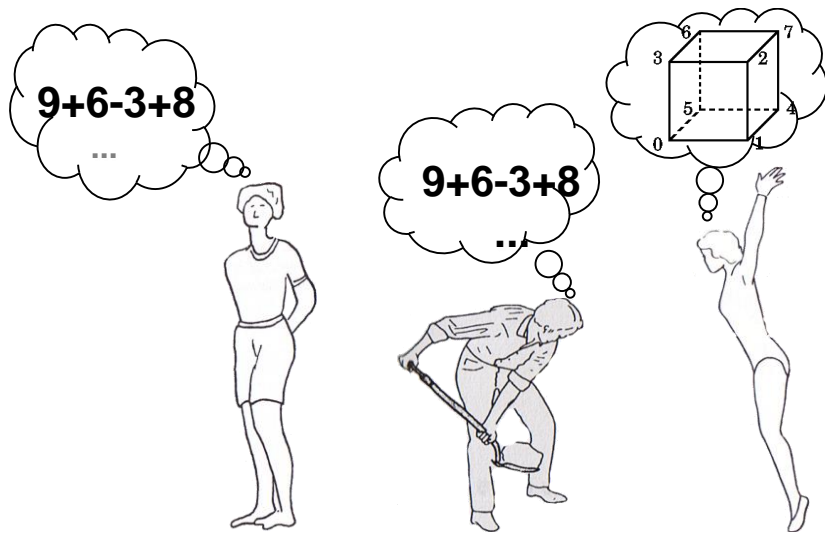
**EARLY SENSORIMOTOR
ACTIVITY
FAVORING
NEURAL PLASTICITY**

ACUTE STAGE
(Fast reorganizations)

CHRONIC STAGE
Functional Reorganizations
depending on the patients
and the context



Dual Task



Visual Feedback on stable/unstable platform



3D Virtual Reality



COGNITIVE TRAINING
versus
TRADITIONAL VESTIBULAR REHAB

TRADITIONAL

- **Promote alternative Strategies (for gaze and posture stabilization)**
- **Increase the Weight of Vision**
- **Increase the Weight of Proprioception**
- **Increase the Smooth Pursuit System**
- **Potentiate the Cervico-ocular Reflex**
- **Convert Overt into Covert Saccades**

COGNITIVE

- **Mental rotation and Motor Imagery training (Imagining head/whole body movements)**
- **Activation of temporo-parietal areas**
- **Improve the ability to predict**
- **Increase the confidence in the predictions**
- **Cost-effective, at patient's own home**

**HOW
TO
CONCLUDE ?**

1. DIFFERENT GOALS FOR VESTIBULAR REHABILITATION THERAPY (VR)

- Enhance Adaptation Processes,
- Reweight the Sensory Inputs,
- Habituate to Challenging Contexts,
- Increase Confidence in Predictions (Cognitive Training)

2. CURRENTLY, VR IS OFTEN USED IN AN UNSPECIFIC WAY

- Irrespective of the clinical findings
- Depend on the educational level of the physiotherapists
- No consensus on the best method, if any

3. NEURO-OTOLOGIST COMMUNITY MUST THEREFORE

- Improve the educational level to perform the right diagnosis and propose the best VR (adapted to each particular patient)
- Increase the basic knowledge for better translational transfert to vestibular patients



**I THANK YOU
FOR
YOUR ATTENTION**