Speaker: Joe Xing, PhD
Entrepreneur | Visiting Professor at Tsinghua University | Advising and Consulting with FNC on AI Technology

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FNC NeuroRecharge

RESEARCH COLLABORATION WEEK

Hosted at

The Functional Neurology Center

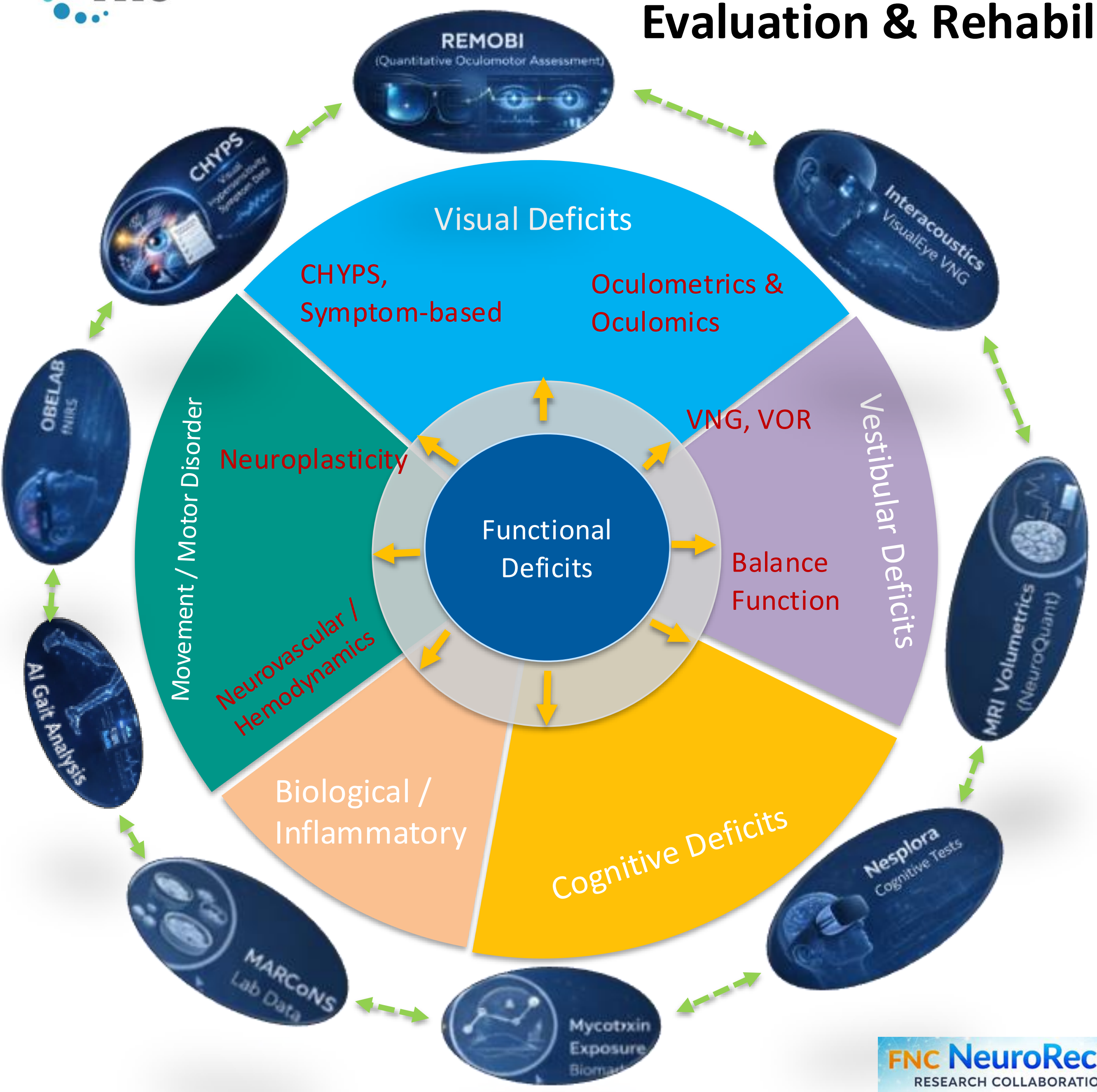
Minnetonka, Minnesota

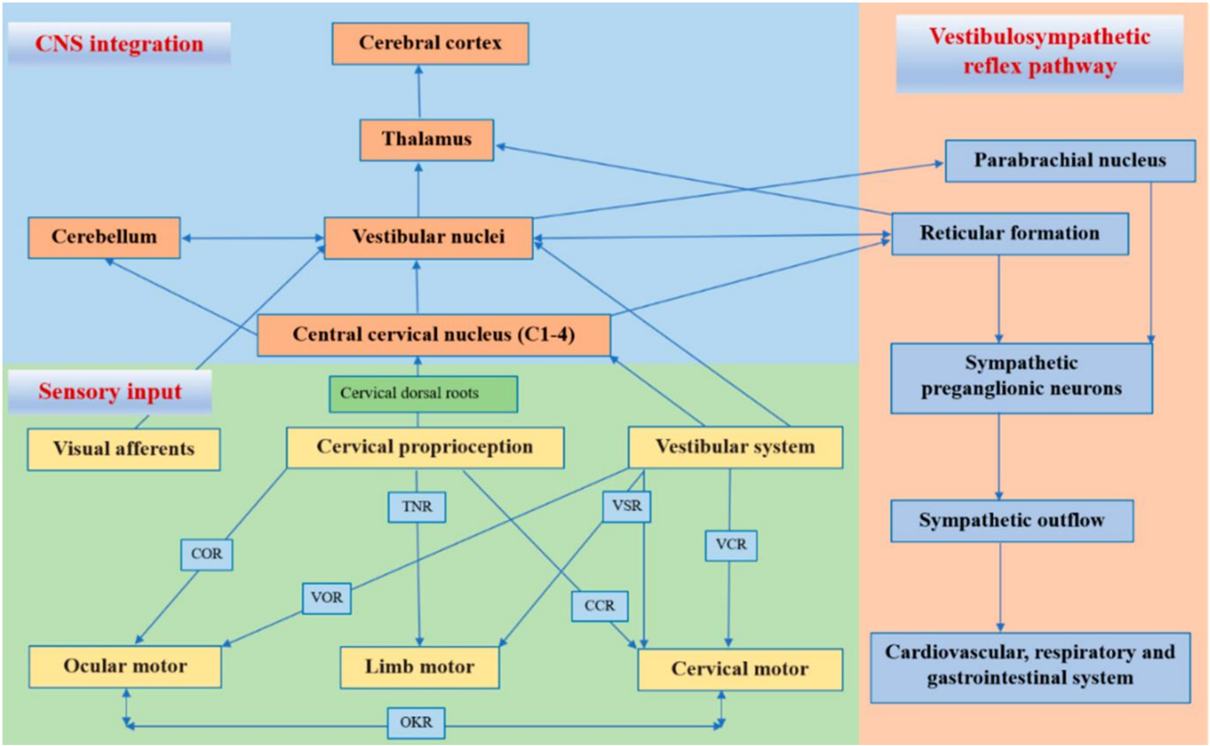
Where Clinical Innovation Meets Translational Neuroscience

Introduction

- Bringing together clinicians, AI technologists, researchers, and collaborators to advance translational neuroscience at The Functional Neurology Center.
- Showcasing how multimodal AI can transform real-world clinical data into structured, publishable research across symptoms, biomarkers, imaging, vestibular, and gait domains.
- Building scalable research infrastructure to support discovery, rehabilitation validation, and the future of personalized brain health, patient-centric care.

Developing a Comprehensive Multimodal Clinical Data-Driven Evaluation & Rehabilitation Ecosystem





Li Y, Yang L, Dai C, Peng B. **Proprioceptive Cervicogenic Dizziness: A Narrative Review of Pathogenesis, Diagnosis, and Treatment.** *Journal of Clinical Medicine.* 2022;11(21):6293. https://doi.org/10.3390/jcm11216293

SchmoeXing
FUNCTIONAL NEUROLOGY
RESEARCH LAB

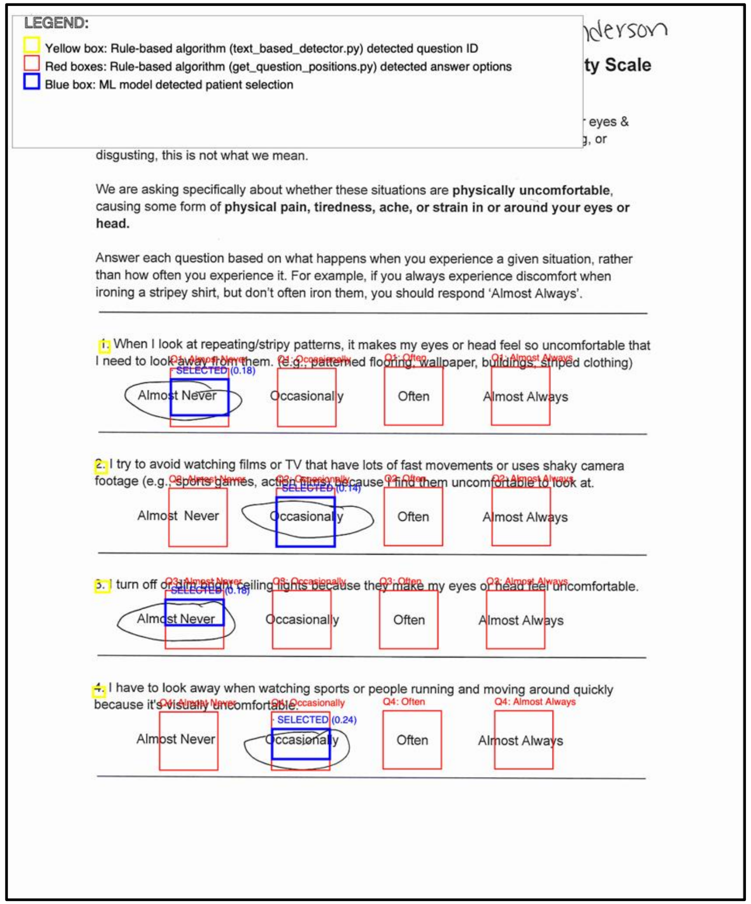
pioneering *innovative* brain health solutions

Showcase | Demo

Clinical Document Intelligence: Automated CHYPS Grading using AI / ML

- Automated extraction of symptom responses (OCR, etc.)
- Goal: scalable research-ready symptom datasets for multimodal analysis

Automatically detected
Yellow: question ID
Red: answers / options
Blue: patient selected



LEGEND:
Yellow box: Rule-based algorithm (text_based_detector.py) detected question ID
Red boxes: Rule-based algorithm (get_question_positions.py) detected answer options
Blue box: ML model detected patient selection

ty Scale

disgusting, this is not what we mean.

We are asking specifically about whether these situations are **physically uncomfortable**, causing some form of **physical pain, tiredness, ache, or strain in or around your eyes or head.**

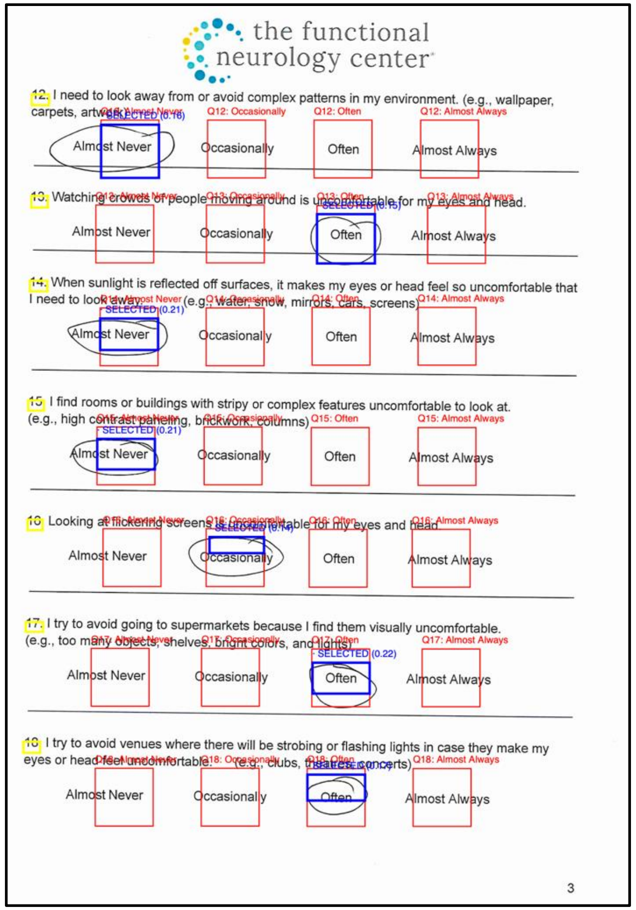
Answer each question based on what happens when you experience a given situation, rather than how often you experience it. For example, if you always experience discomfort when ironing a stripey shirt, but don't often iron them, you should respond 'Almost Always'.

1. When I look at repeating/stripy patterns, it makes my eyes or head feel so uncomfortable that I need to look away from them. (e.g., patterned flooring, wallpaper, buildings, striped clothing)
Almost Never | Occasionally | Often | Almost Always

2. I try to avoid watching films or TV that have lots of fast movements or uses shaky camera footage (e.g., sports games, action films) because I find them uncomfortable to look at.
Almost Never | Occasionally | Often | Almost Always

3. I turn off overhead ceiling lights because they make my eyes or head feel uncomfortable.
Almost Never | Occasionally | Often | Almost Always

4. I have to look away when watching sports or people running and moving around quickly because it's visually uncomfortable.
Almost Never | Occasionally | Often | Almost Always



the functional neurology center

12. I need to look away from or avoid complex patterns in my environment. (e.g., wallpaper, carpets, artwork)
Almost Never | Occasionally | Often | Almost Always

13. Watching crowds of people moving around is uncomfortable for my eyes and head.
Almost Never | Occasionally | Often | Almost Always

14. When sunlight is reflected off surfaces, it makes my eyes or head feel so uncomfortable that I need to look away. (e.g., water, snow, mirrors, cars, screens)
Almost Never | Occasionally | Often | Almost Always

15. I find rooms or buildings with stripy or complex features uncomfortable to look at. (e.g., high contrast paneling, brickwork, columns)
Almost Never | Occasionally | Often | Almost Always

16. Looking at flickering screens is uncomfortable for my eyes and head.
Almost Never | Occasionally | Often | Almost Always

17. I try to avoid going to supermarkets because I find them visually uncomfortable. (e.g., too many objects, shelves, bright colors, and lights)
Almost Never | Occasionally | Often | Almost Always

18. I try to avoid venues where there will be strobing or flashing lights in case they make my eyes or head feel uncomfortable. (e.g., clubs, theatre, concerts)
Almost Never | Occasionally | Often | Almost Always

3

Clinical Document Intelligence: Automated CHYPS Grading using AI / ML

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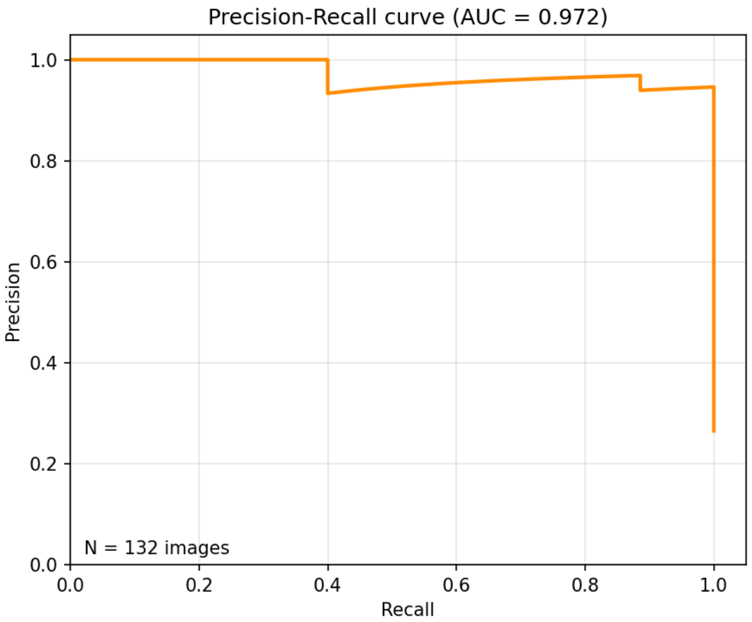
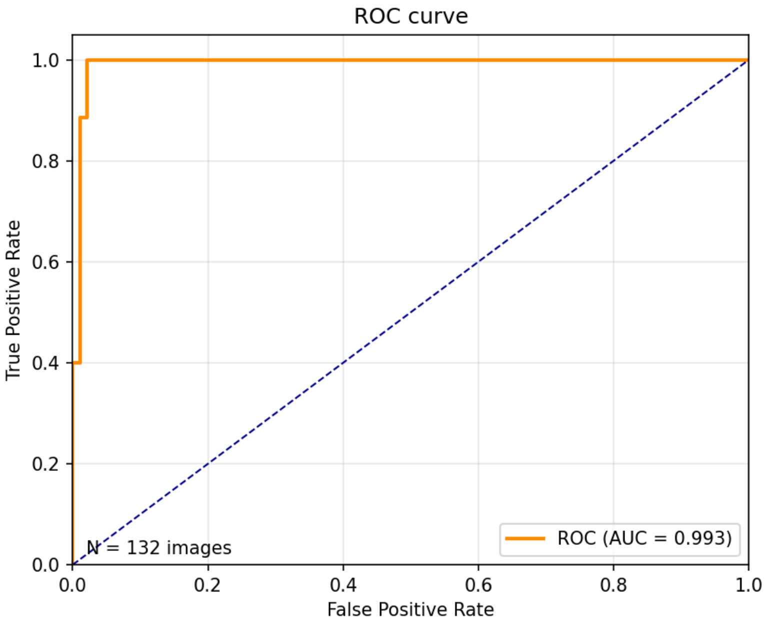
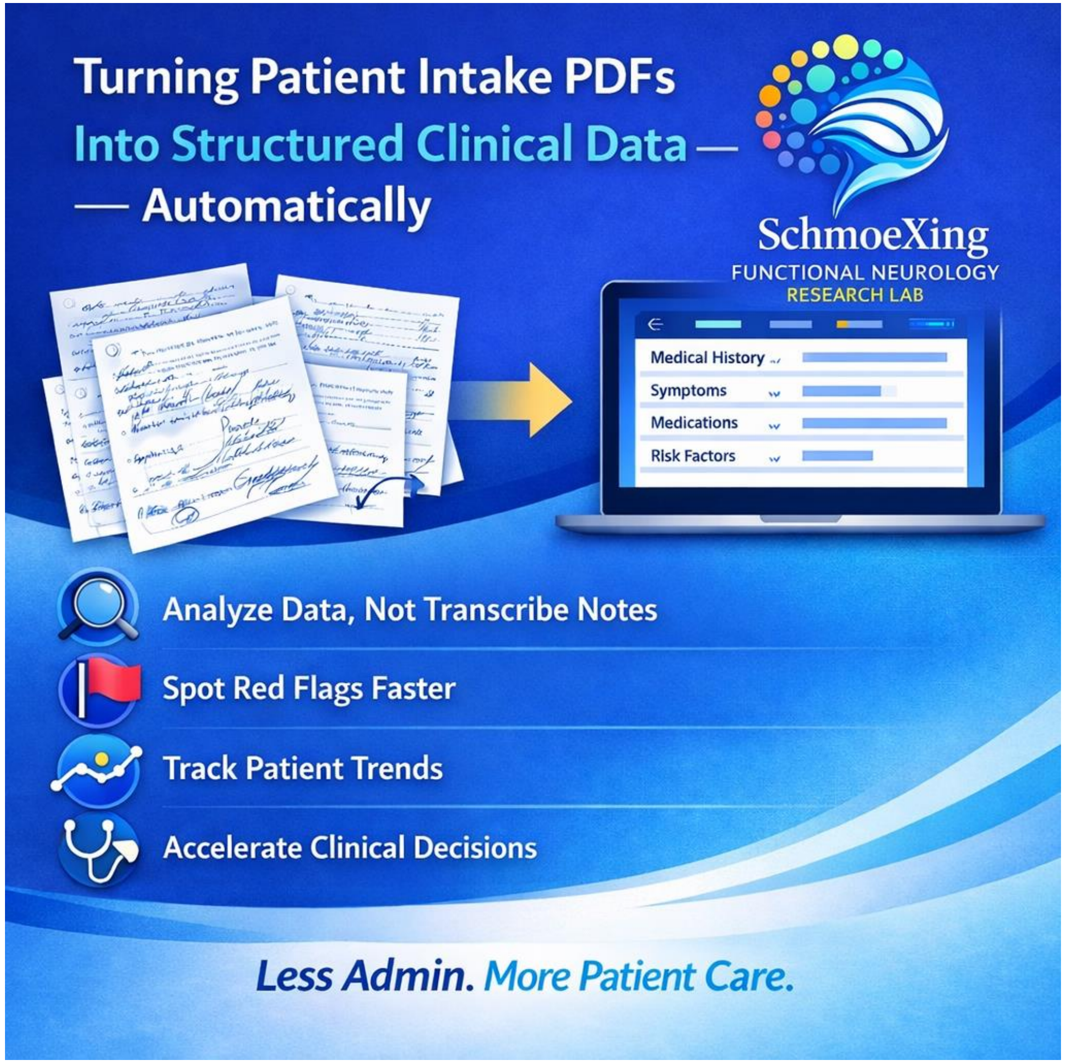
- Goal: scalable research-ready symptom datasets for multimodal analysis







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Cardiff Hypersensitivity Scale

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   Almost Never Occasionally Often Almost Always

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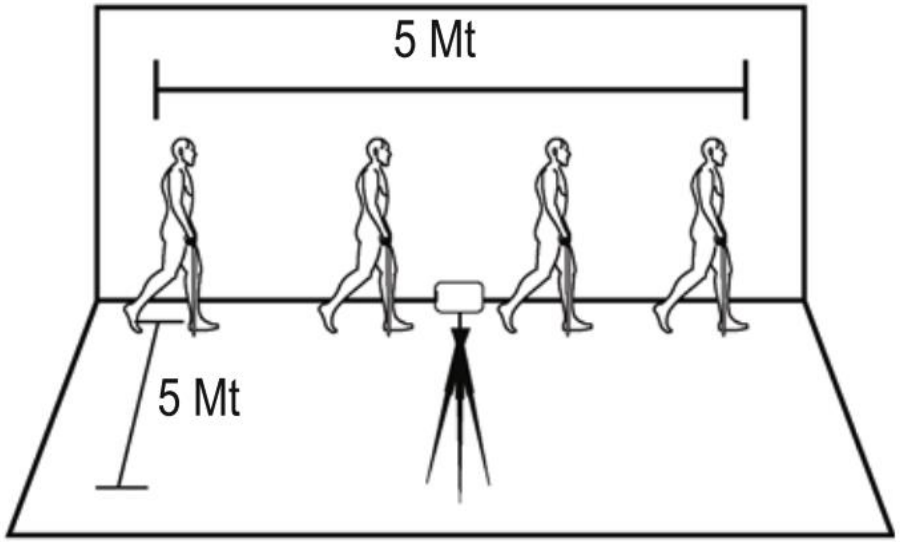
Video Demo

Malta Gait Scale (MGS) and Wisconsin Gait Scale (WGS)

- Data-driven rehabilitation tools like MGS provide **objective**, reliable, and time-efficient gait measurements that enable accurate progress tracking and evidence-based clinical decision-making.
- MGS evaluates 7 key gait components: support, contact area of foot, arm swing reflex, joint relations (position of leg during load), knee flexion, hip hiking (reverse gait), foot direction (18 - 100 points)
- The gait is recorded using a stationary smartphone camera positioned 5 meters away at hip height in a sagittal view (5 m walk), ensuring full-body visibility with proper lighting and no camera movement.

Sagittal view



Sarmati V, Carmona C, Morciano A, Gutiérrez S, Velásquez I, Fernández J. Validation of the Malta Gait Scale: A Time-Efficient Tool for Poststroke Assessment. Stroke Research and Treatment. 2025;2025:Article ID 8849857. https://doi.org/10.1155/srat/8849857

Gait assessments objectively identify post-concussion deficits

David R. Howell, et. al., Dual-Task Gait Recovery after Concussion among Female and Male Collegiate Athletes. Med Sci Sports Exerc . 2020 May ; 52(5): 1015–1021. doi:10.1249/MSS.0000000000002225.

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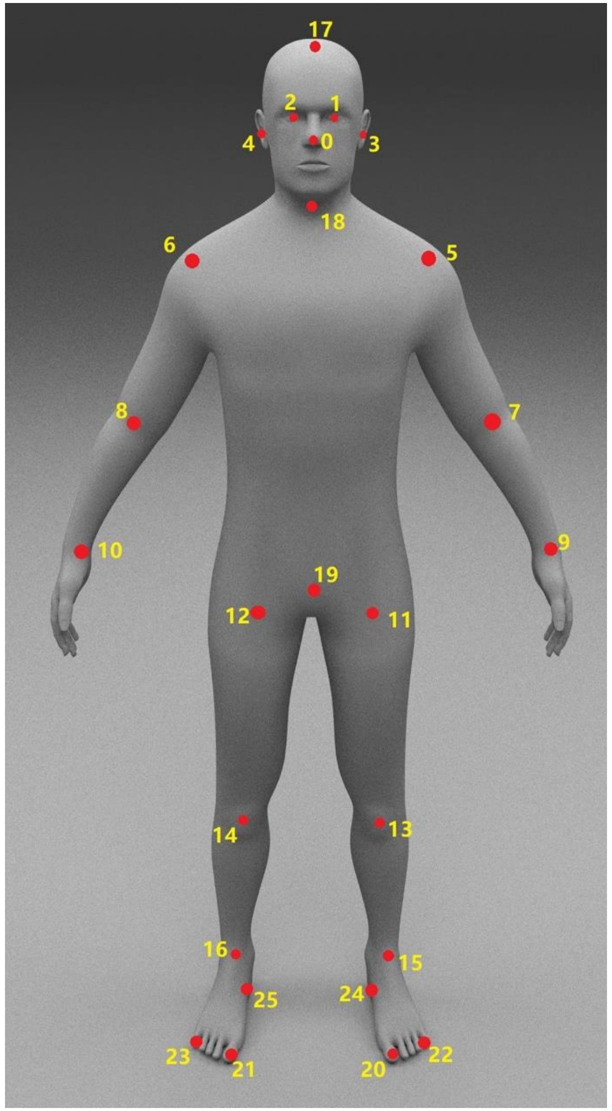
OpenPose 25+1 Standard

- OpenPose is a widely used computer vision standard for real-time multi-person 2D skeletal keypoint detection that enables markerless extraction of joint coordinates, which is crucial for AI-based gait analysis because it allows precise quantification of posture, stride, symmetry, and movement dynamics from ordinary video without wearable sensors.

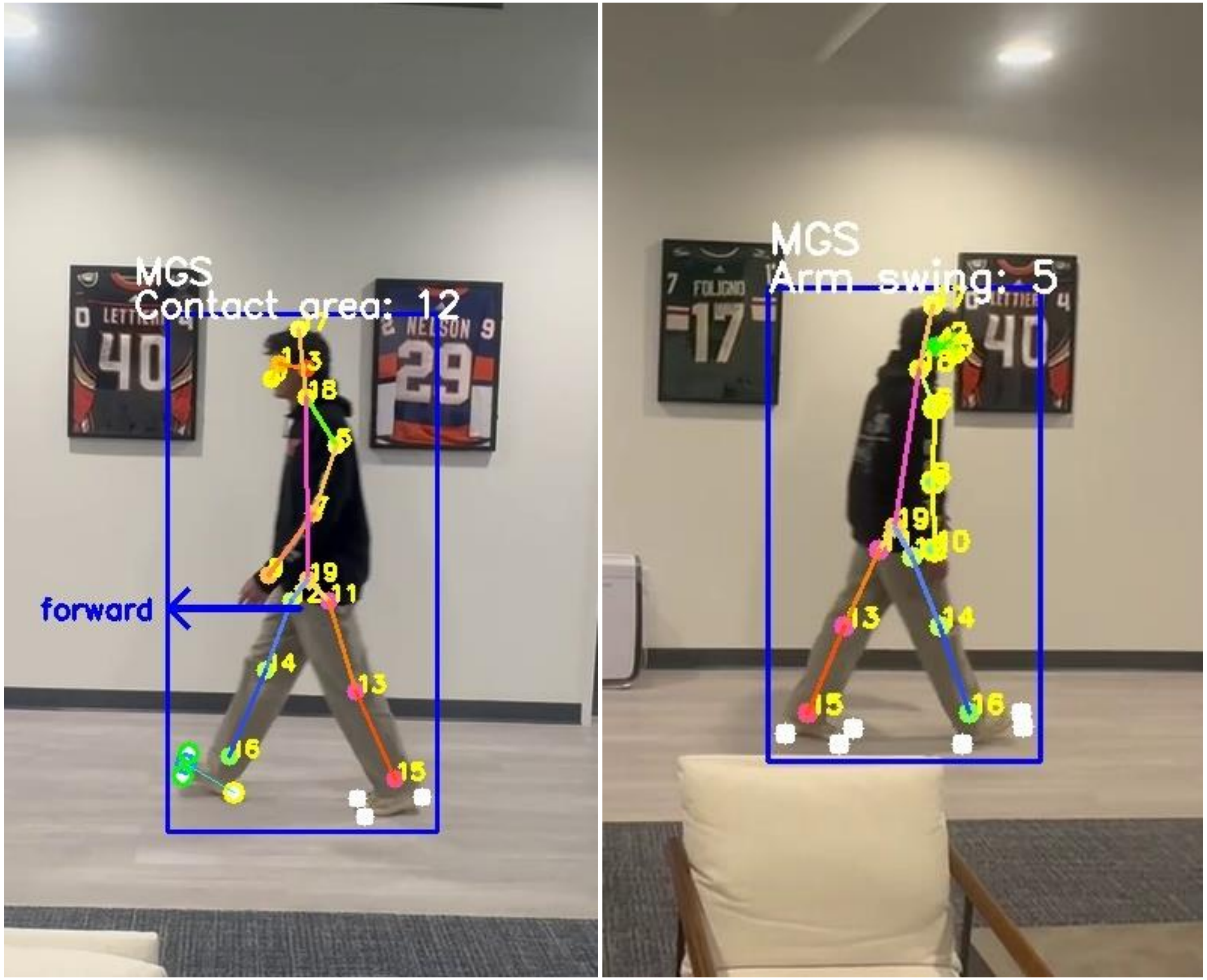
- 17: Vertex
- 2: Right eye
- 1: Left eye
- 0: Nose
- 4: Right ear
- 3: Left ear
- 18: Neck
- 6: Right shoulder
- 5: Left shoulder
- 8: Right elbow
- 7: Left elbow
- 10: Right wrist
- 9: Left wrist

- 12: Right hip
- 11: Left hip
- 14: Right knee
- 13: Left knee
- 16: Right ankle
- 15: Left ankle
- 19: Mid hip (pelvis center)
- 21: Right big toe
- 23: Right small toe
- 25: Right heel
- 20: Left big toe
- 22: Left small toe
- 24: Left heel



AI-Driven Video-Based Analysis for Malta Gait Scale Assessment

- This is an example for demonstration purpose only
- Assumption: paretic side is right-hand-side. The patient may use a cane on the left (non-paretic) side for support.
- For assessment, the Foot Contact Area Test is evaluated from the non-paretic side. All other tests are done on paretic side.
- In a patient with concussion or mild traumatic brain injury (mTBI), a perpendicular arm swing may indicate impaired motor coordination and balance control due to disrupted neuromuscular integration.



Sagittal view

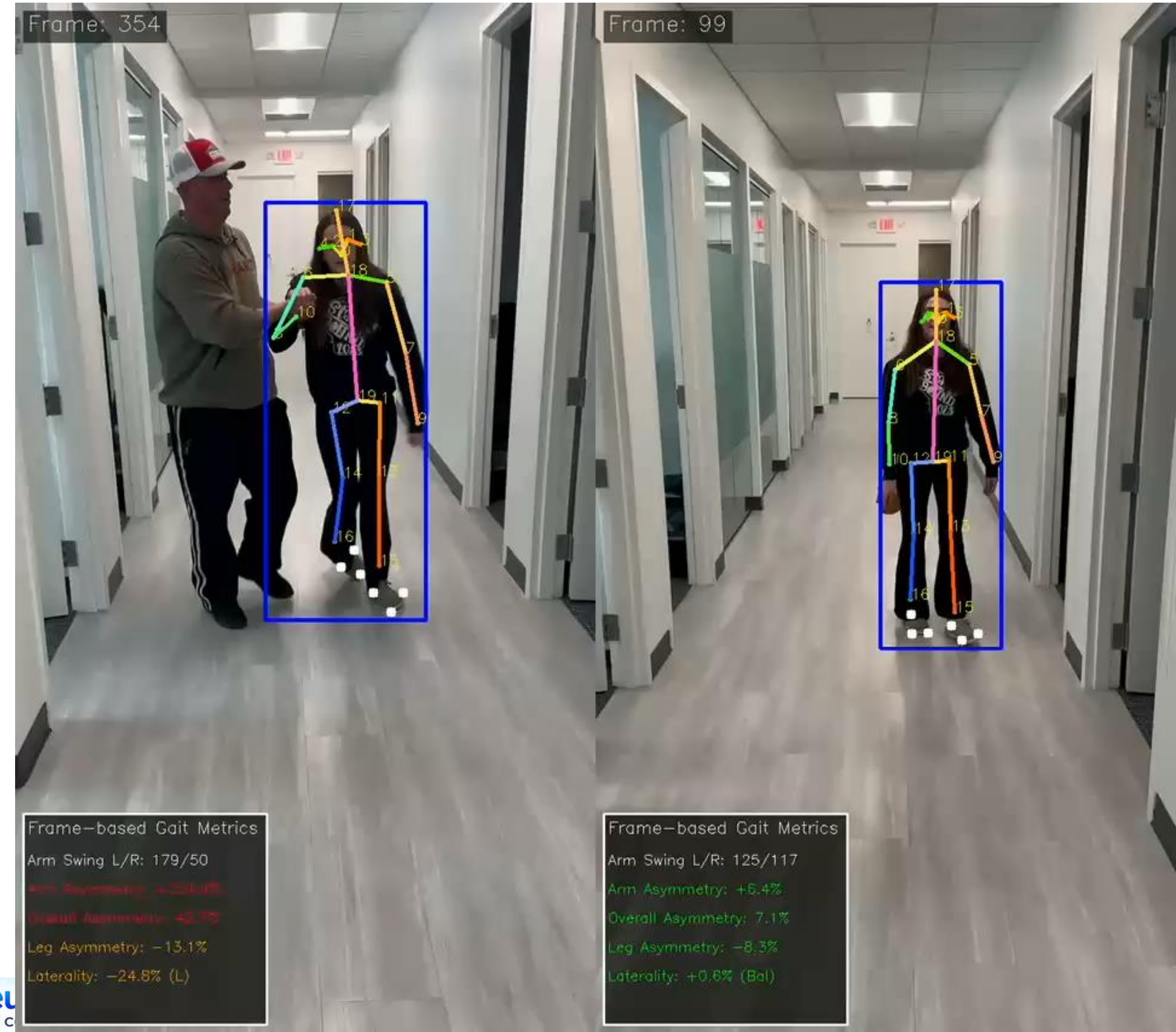
FNC NeuroRecharge RESEARCH COLLABORATION WEEK

More on Gait Analysis

- We use video-based large-scale models to estimate patient posture, detect key body points, and analyze critical postural components, as illustrated on the right.
- Arm swing can be quantified using both upper limb angular motion and shoulder-to-wrist extension length, while also assessing left–right asymmetry in arm swing amplitude to detect compensatory gait patterns.
- Laterality is the average of (right − left)/(right + left) for arm swing and for leg length, expressed as a percentage, so positive values mean right-side dominance and negative values mean left-side dominance.

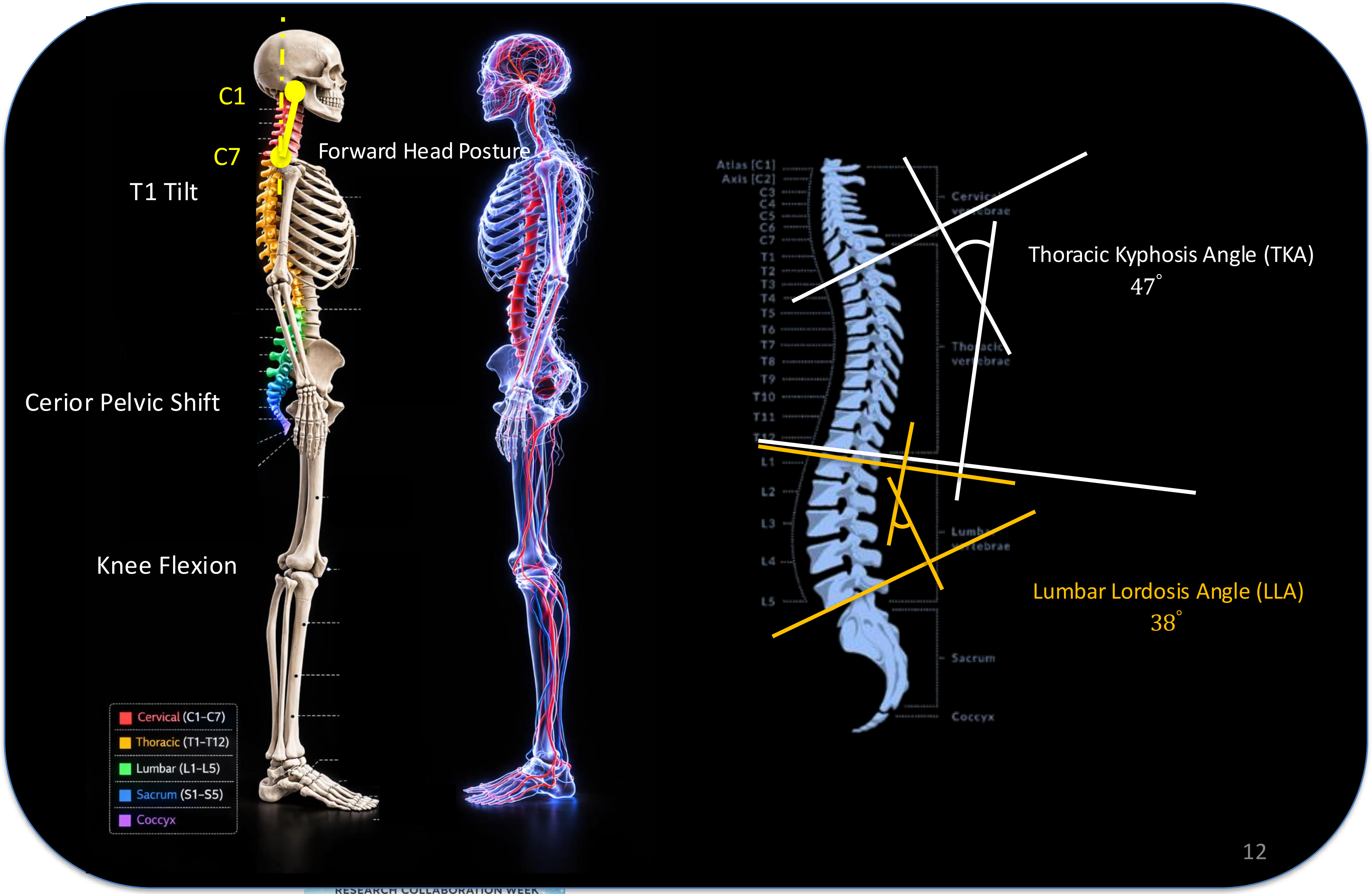
Coronal view

Video Demo



Anatomical Keypoint Mapping System (AKMS)

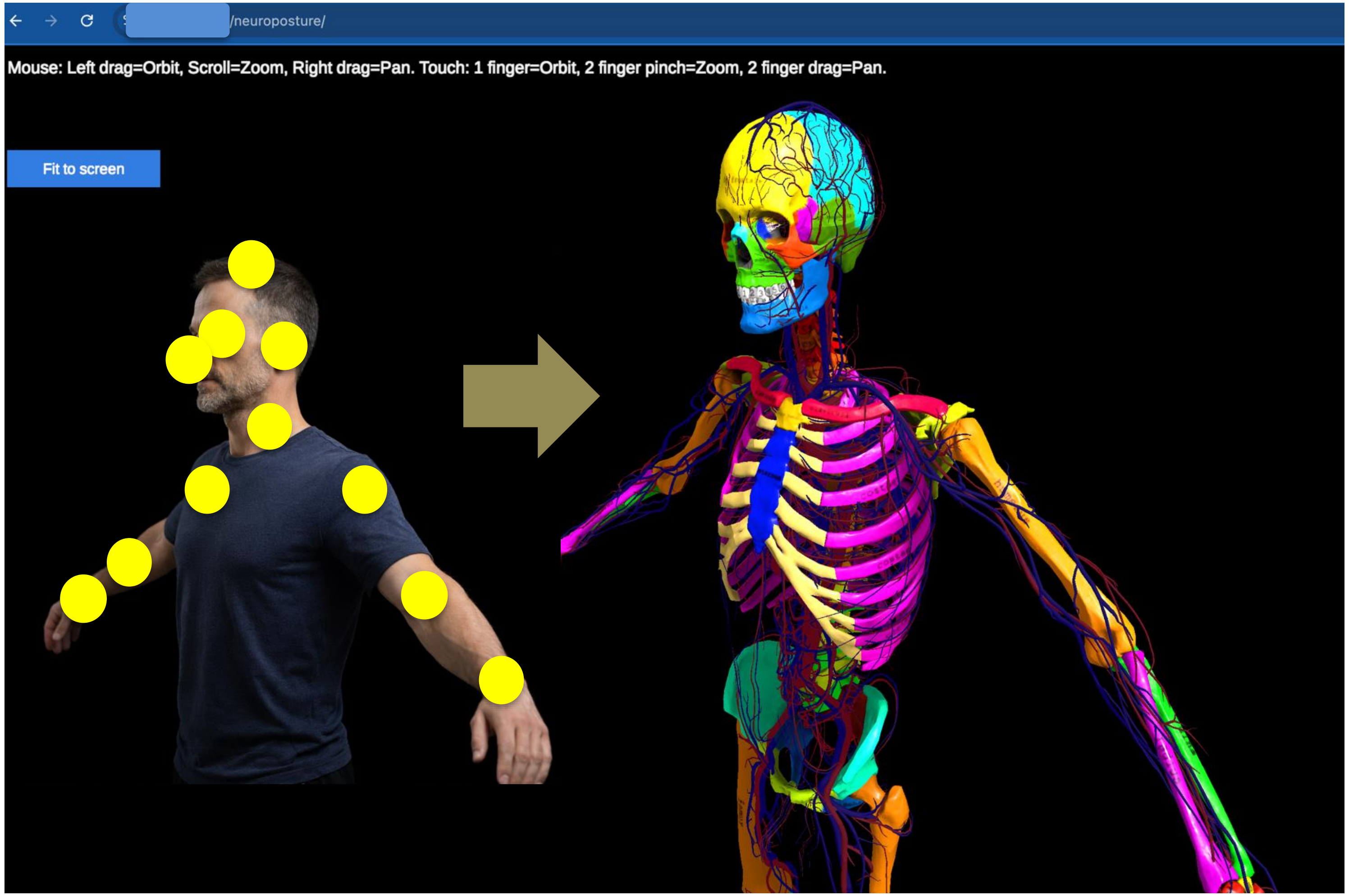
- We are evolving from a generic 25-keypoint OpenPose model to an anatomically informed skeletal mapping system that aligns with true biomechanical landmark: C1–C7 (cervical), T1–T12 (thoracic), lumbar vertebrae, pelvis, and other structural segments, to enable clinically meaningful posture and spinal analysis.



NeuroPosture™ – AI-Powered Postural Intelligence

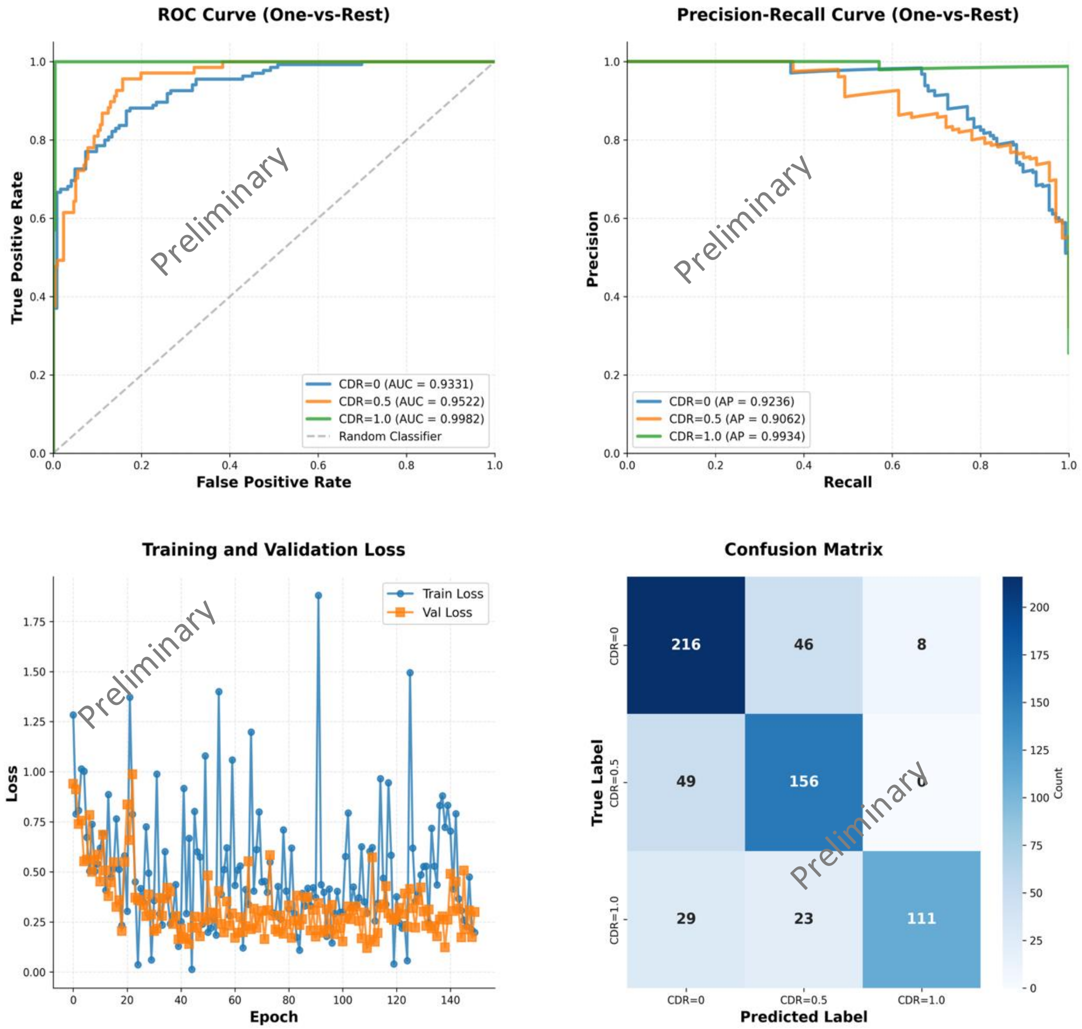
- Clinical platform designed to provide clinicians with automated, video-based postural assessment tools that patients can perform at home.
- Using advanced computer vision and 3D biomechanical modeling, the system analyzes patient-recorded videos to simulate and quantify key spinal and alignment metrics, including Thoracic Kyphosis Angle (TKA), Lumbar Lordosis Angle (LLA), pelvic shift, and forward head posture.

TO-BE-RELEASED-SOON



AI-Powered Alzheimer's Severity Prediction Using MRI and Vision Transformers

- Clinical Dementia Rating (CDR) is a clinician-administered scale used to assess the severity of cognitive impairment in Alzheimer's disease, ranging from 0 (normal) to 3 (severe dementia)
- We use the open-source OASIS MRI dataset, extracting sagittal, coronal, and axial views from 3D voxel brain volumes to train our model
- The Vision Transformer-based AI learns structural biomarkers such as white matter volume changes, hippocampal atrophy, and entorhinal cortex degeneration to predict CDR severity

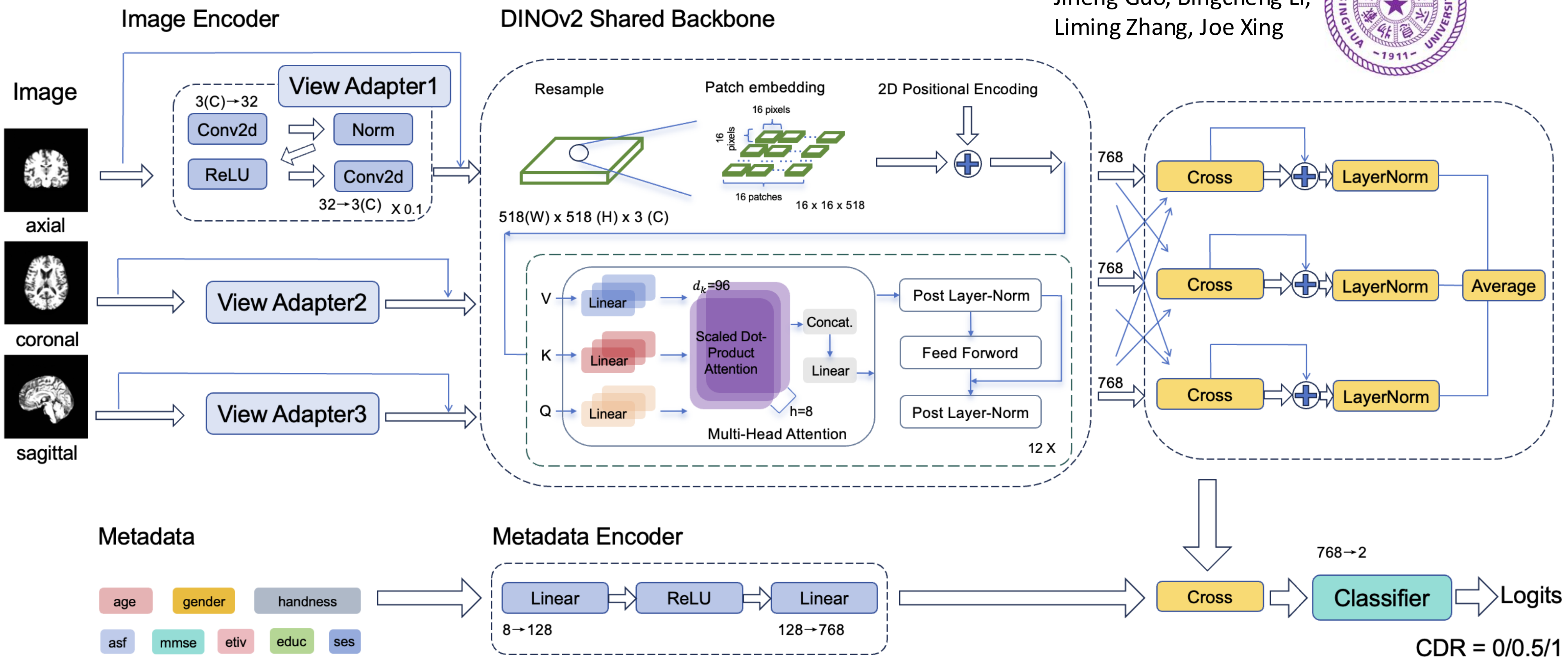


Shenghao Lv, Rican Deng, Jiheng Guo, Bingcheng Li, Liming Zhang and Joe Xing

Model Architecture

- ViT transformer-based model, added meta-data such as cognitive screening test MMSE, education/occupation level, etc.

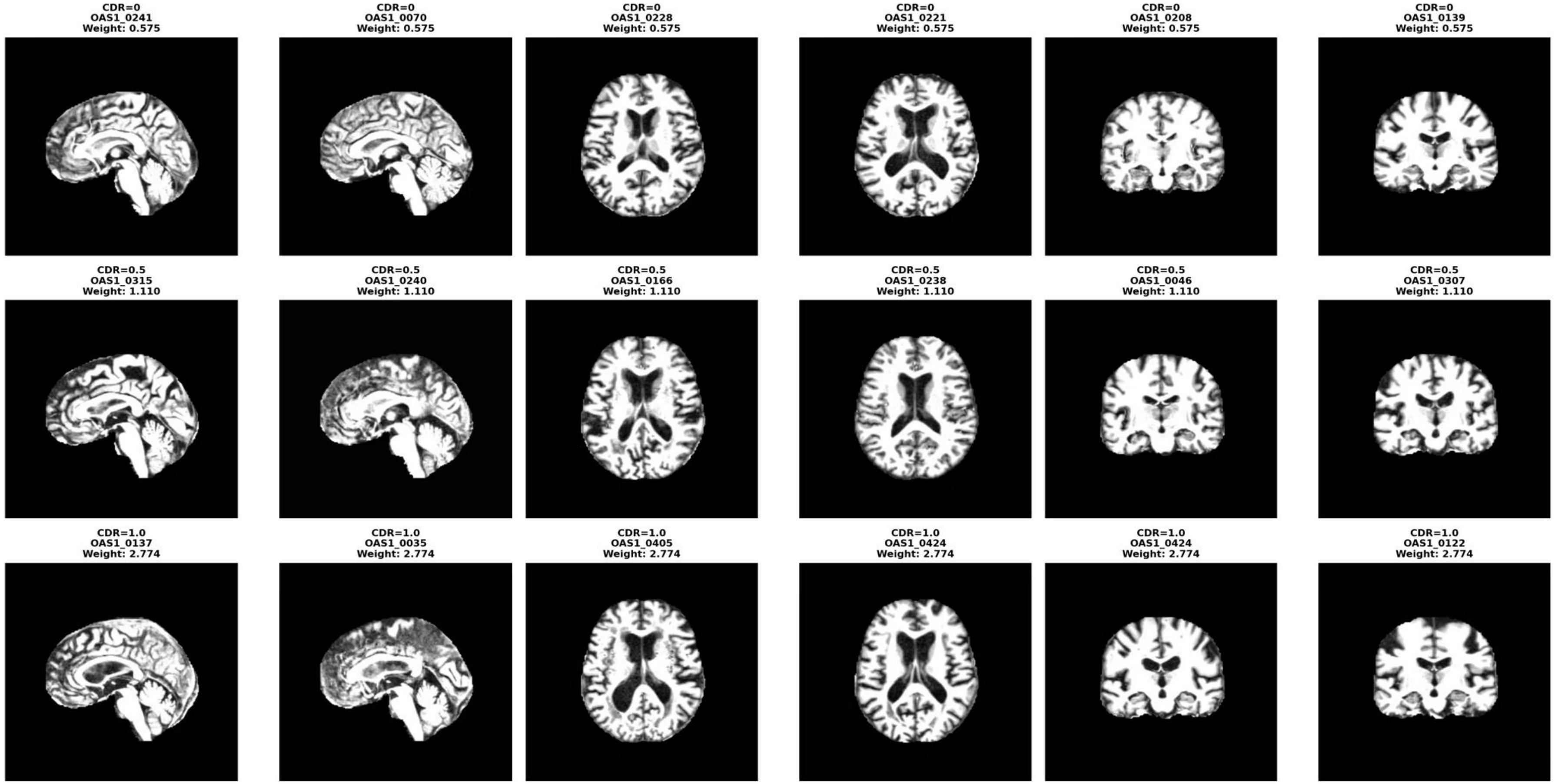
Shenghao Lv, Rican Deng, Jiheng Guo, Bingcheng Li, Liming Zhang, Joe Xing



Oquab M, et. al. *DINOv2: Learning Robust Visual Features without Supervision. Transactions on Machine Learning Research.* 2024; (preprint) arXiv:2304.07193. doi:10.48550/arXiv.2304.07193.

OASIS MRI Image Data

- The OASIS-1 dataset contains 416 subjects (including ~100 with Alzheimer’s disease) with T1-weighted 1.5T Siemens MRI scans.
- Defacing and skull stripping were performed to remove non-brain structures, preventing the AI model from learning irrelevant features outside the brain.

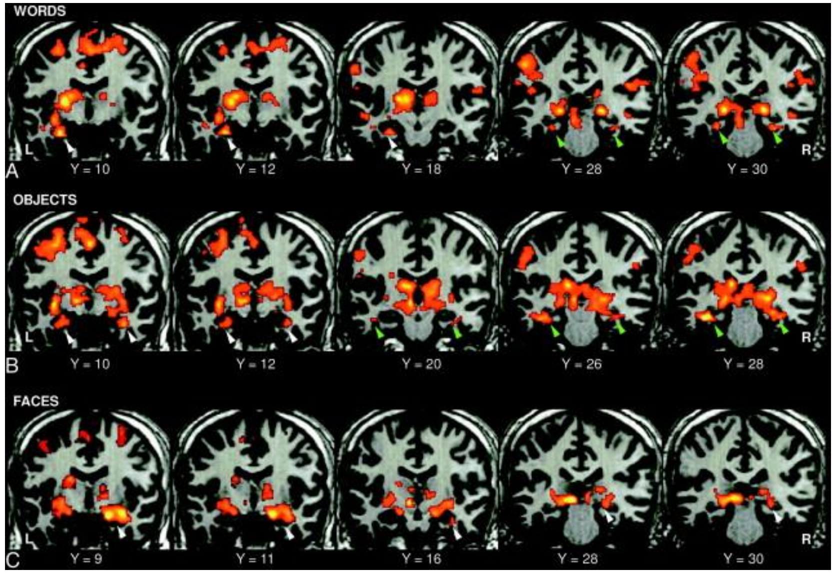


Shenghao Lv, Rican Deng, Jiheng Guo, Bingcheng Li, Liming Zhang, Joe Xing

Marcus DS, Wang TH, Parker J, Csernansky JG, Morris JC, Buckner RL. Open Access Series of Imaging Studies (OASIS): Cross-sectional MRI data in young, middle aged, nondemented, and demented older adults. J Cogn Neurosci. 2007;19(9):1498–1507. doi:10.1162/jocn.2007.19.9.1498.

Hippocampus and Entorhinal Cortex: Early Structural Biomarkers of Alzheimer's Disease

- The hippocampus and entorhinal cortex are key memory-related brain regions that undergo early atrophy in Alzheimer's disease, making them critical structural biomarkers for disease onset and progression.
- This study used functional MRI to show that the medial temporal lobe, including the hippocampus, is actively engaged in both verbal and nonverbal memory tasks, highlighting its central role in memory processing.



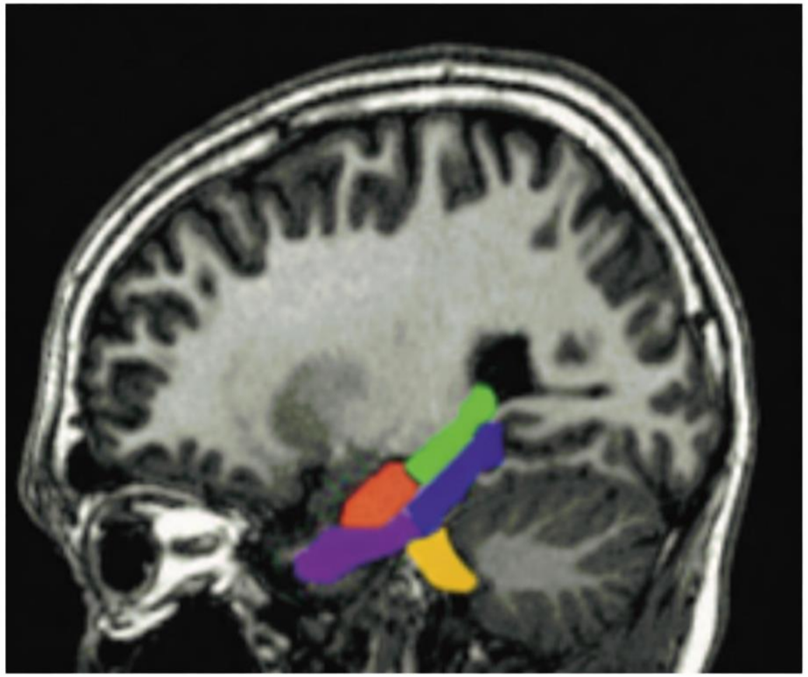
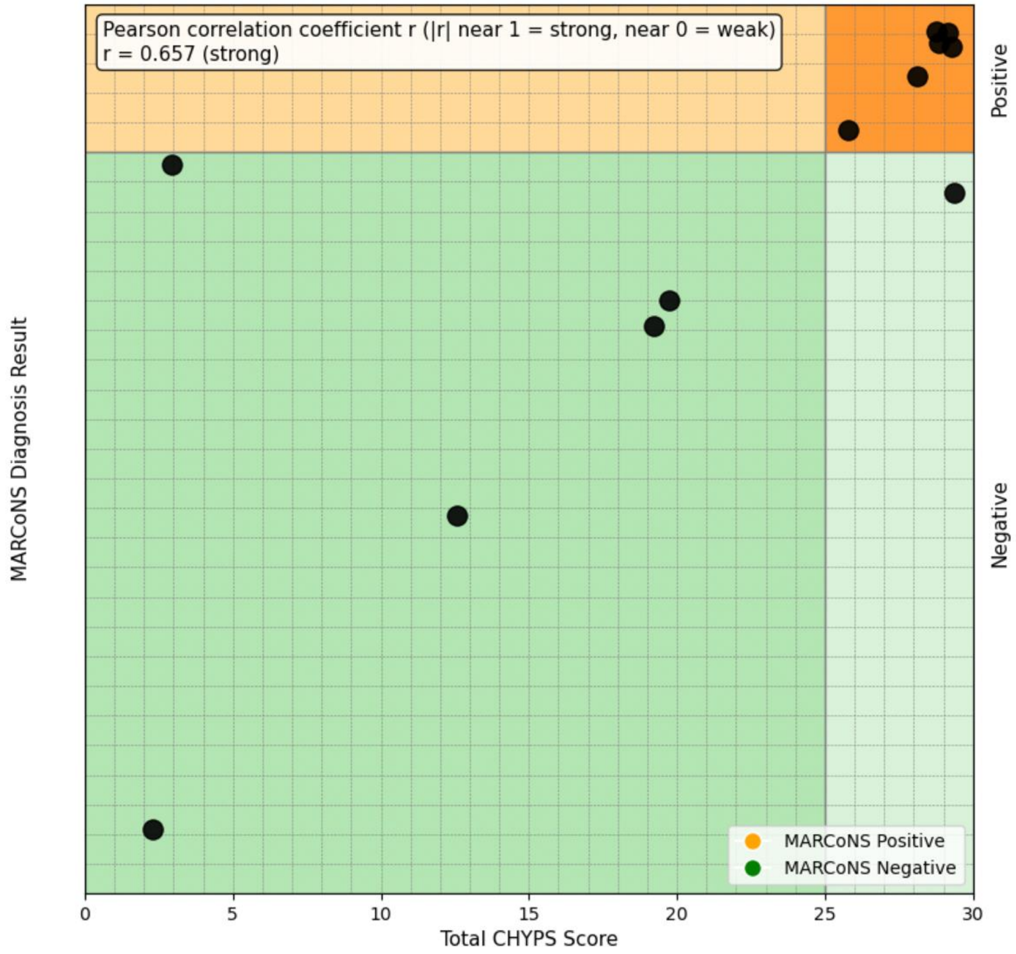


Fig 1. Sagittal view of ROIs for a representative subject. Hippocampus: head in red; body and tail in green. Parahippocampal gyrus: anterior half in violet; posterior half in blue. Entorhi cortex: in yellow.

Rosazza C, Minati L, Ghielmetti F, et al. *Engagement of the medial temporal lobe in verbal and nonverbal memory: assessment with functional MR imaging.* AJNR American Journal of Neuroradiology. 2009;30(6):1134–1141. doi:10.3174/ajnr.A1515

Nasal MARCoNS and Visual Hypersensitivity: Observed Association

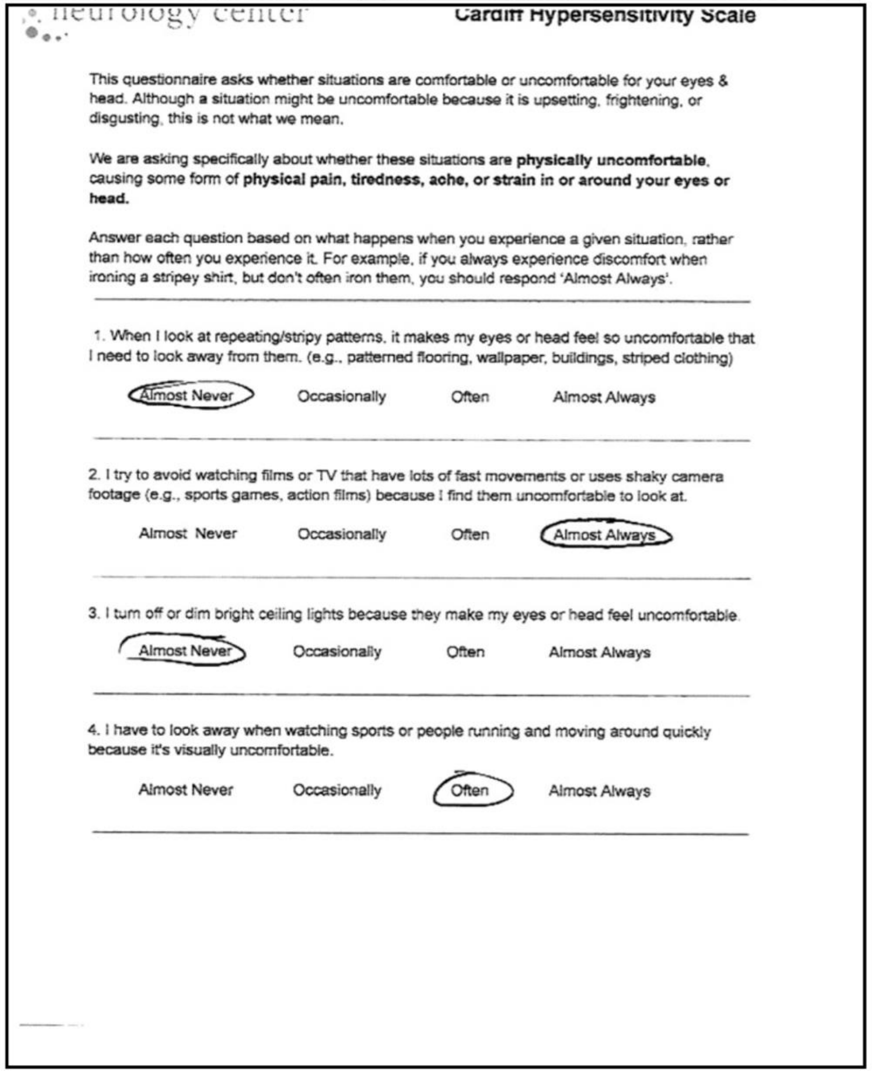
- The matched cohort included 12 patients. Of these, 8 were female and 4 were male. Age ranged from 23 to 66 years, with mean 48.6 (standard deviation = 14.02).
- Pearson analysis (r = 0.657) showed a moderate positive association between higher CHYPS visual hypersensitivity scores and MARCoNS positivity, though findings are exploratory due to small sample size.



CHYPS: A Quantitative Measure of Visual Hypersensitivity

- CHYPS (Cardiff Hypersensitivity Scale) is a 20-question self-report measure of visual hypersensitivity comprising four subtypes: brightness sensitivity, motion sensitivity, pattern sensitivity, and sensitivity to intense visual environments
- CHYPS items are scored on a 4-point Likert scale (Almost Never, Occasionally, Often, Almost Always), coded 0–3, yielding a total score range of 0–60 across the 20 items.
- It is designed this way to capture frequency or severity gradation without a neutral midpoint, reducing response ambiguity and encouraging clearer symptom discrimination while maintaining simple, ordinal scoring for statistical analysis (symptom-based)

CHYPS (Patient 0): Pre-therapy – Page 1 of 4



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Almost Never   Occasionally   Often   Almost Always

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Antibiotic Sensitivity Profile in MARCoNS

- MARCoNS testing evaluates these antibiotics to determine which medications the bacteria are susceptible or resistant to, guiding targeted and effective antimicrobial treatment:

  Fluoroquinolones: Ciprofloxacin, Levofloxacin, Moxifloxacin
  Macrolide: Erythromycin
  Lincosamide: Clindamycin
  Aminoglycoside: Gentamicin
  Oxazolidinone: Linezolid (Zyvox)
  Beta-lactams: Oxacillin (Methicillin), Penicillin-G
  Streptogramin: Quinupristin/Dalfopristin (Synercid)
  Rifamycin: Rifampicin
  Tetracyclines: Tetracycline, Doxycycline, Tigecycline
  Sulfonamide combination: Trimethoprim/Sulfamethoxazole (Bactrim)
  Glycopeptide: Vancomycin

```
Patient ID: 1

NARES CULTURE
SOURCE    Nares
MARCoNS: Positive

SUSCEPTIBILITY #1    SUSCEPTIBILITY
ANTIBIOTIC NAME    INTERPRETATION
CIPROFLOXACIN    S
CLINDAMYCIN    R
ERYTHROMYCIN    R
GENTAMICIN    S
LEVOFLOXACIN    S
LINEZOLID(ZYVOX)    S
MOXIFLOXACIN    S
OXACILLIN(METHICILLIN)    S
PENICILLIN-G    R
QUINUP/DALFO(SYNERCID)    S
RIFAMPICIN    S
TETRACYCLINE(DOXYCYCLINE)    S
TIGECYCLINE    S
TRIMETH/SULFA(BACTRIM)    S
VANCOMYCIN    S
S=Susceptibility, I=Intermediate, R=Resistant

FUNGAL
SOURCE    Nares

BIOFILM ANALYSIS
ORGANISM-MARCONS    Moderate 2+
STRONG, MODERATE, OR WEAK IS THE LEVEL OF BIOFILM
PRODUCTION BY THE ORGANISM.
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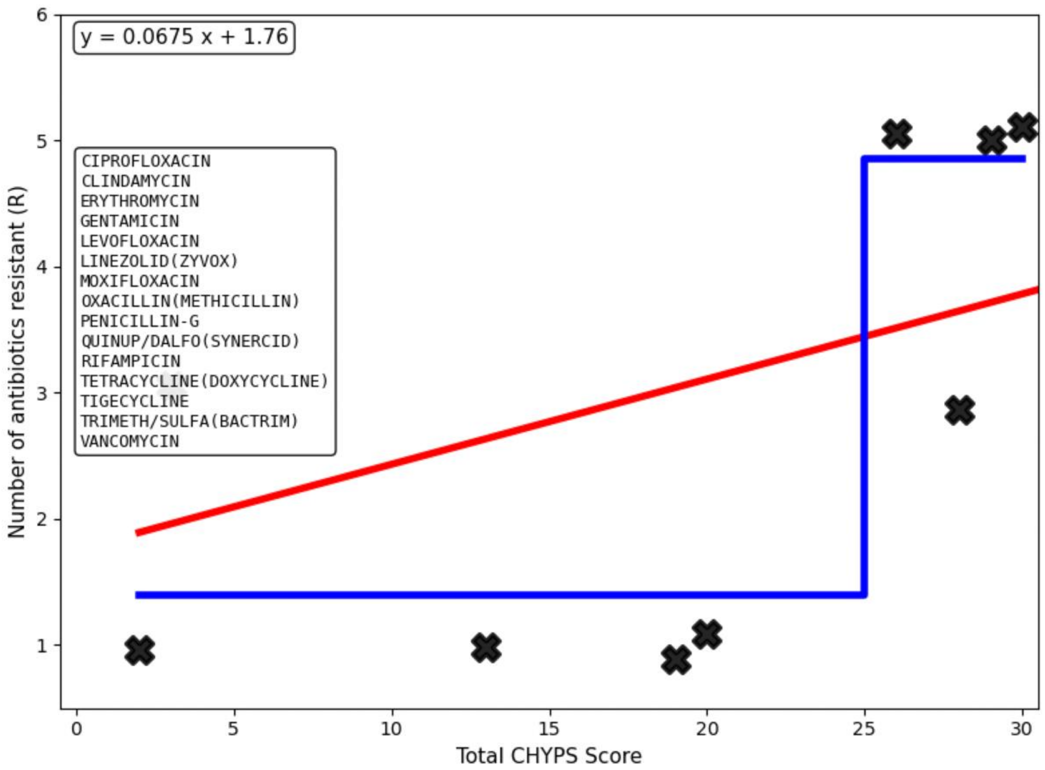
Increasing Antibiotic Resistance with Higher CHYPS Scores

- One possible explanation is that higher CHYPS scores reflect greater neuroinflammatory or immune dysregulation, which may create an environment that supports more persistent or resistant MARCoNS colonization. Alternatively, patients with higher CHYPS scores may have had more prior antimicrobial exposure, contributing to broader antibiotic resistance patterns.



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Conclusions

- We are building a comprehensive, multimodal, data-driven clinical evaluation and rehabilitation ecosystem that integrates biomarkers, imaging, movement analysis, and AI-powered tools into a unified framework for brain health.
- Through research and prototyping: from CHYPS–MARCoNS correlation analysis and AI-driven gait assessment to MRI-based Alzheimer's severity prediction and automated documentation, we showed how data and AI can enhance clinical precision and efficiency.
- Our goal is to reduce administrative burden, increase objective measurement, and give clinicians more time to focus on personalized patient care.