ROMA
17-18 marzo 2026

NEUROYoung
next generation in neurologia
5th edition

Intelligenza Artificiale:
dalla diagnosi al monitoraggio clinico

Lazzaro di Biase, MD, PhD

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Brain Innovations Lab

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Disclosures

L. di Biase has received a speaker honoraria from Bial, consultant honoraria from Abbvie, Bial and Boston Scientific and research funding from Zambon, is the scientific director and one of the shareholders of Brain Innovations Srl, a University spinoff of Campus Bio-Medico University of Rome.

L. di Biase has received support to attend national and international conferences from Abbvie, Bial, Zambon, Boston Scientific.

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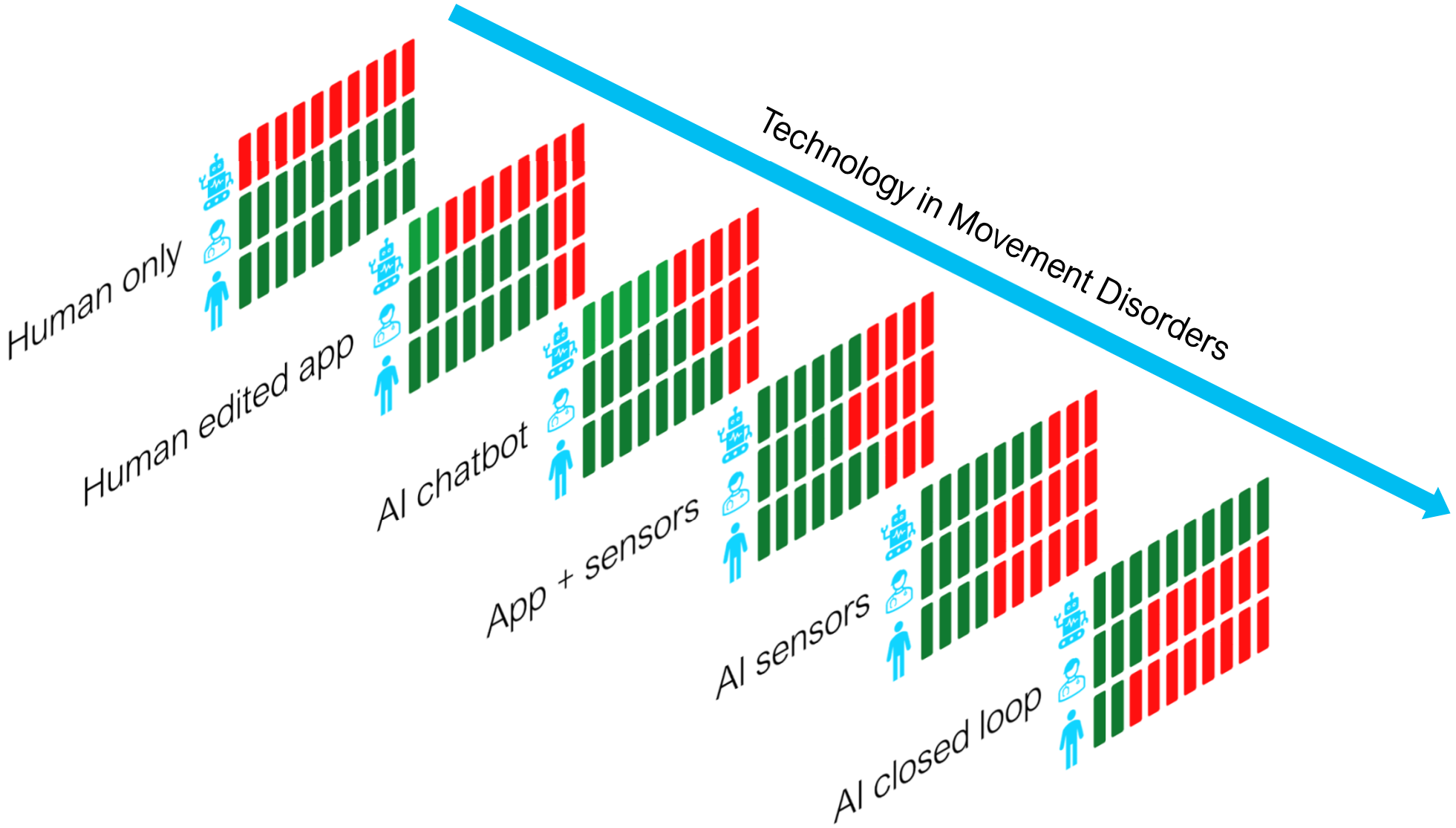

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Research vs clinical practice

	RESEARCH	CLINICAL PRACTICE
Accuracy	High	High
Precision	High	High
Cost/benefit	from Low to High	Low
Invasiveness	from Low to High	Low
User experience	from Easy to Complex	Easy
Ethics committee approval	Needed	Not needed
Med. Dev. Regulatory approval	Partial	Needed (FDA, CE mark…)

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Software as a Medical Device: "software intended to be used for one or more **medical purposes** that perform these purposes **without being part of a hardware medical device**."

Clearly defining Intended use of SaMD

FDA

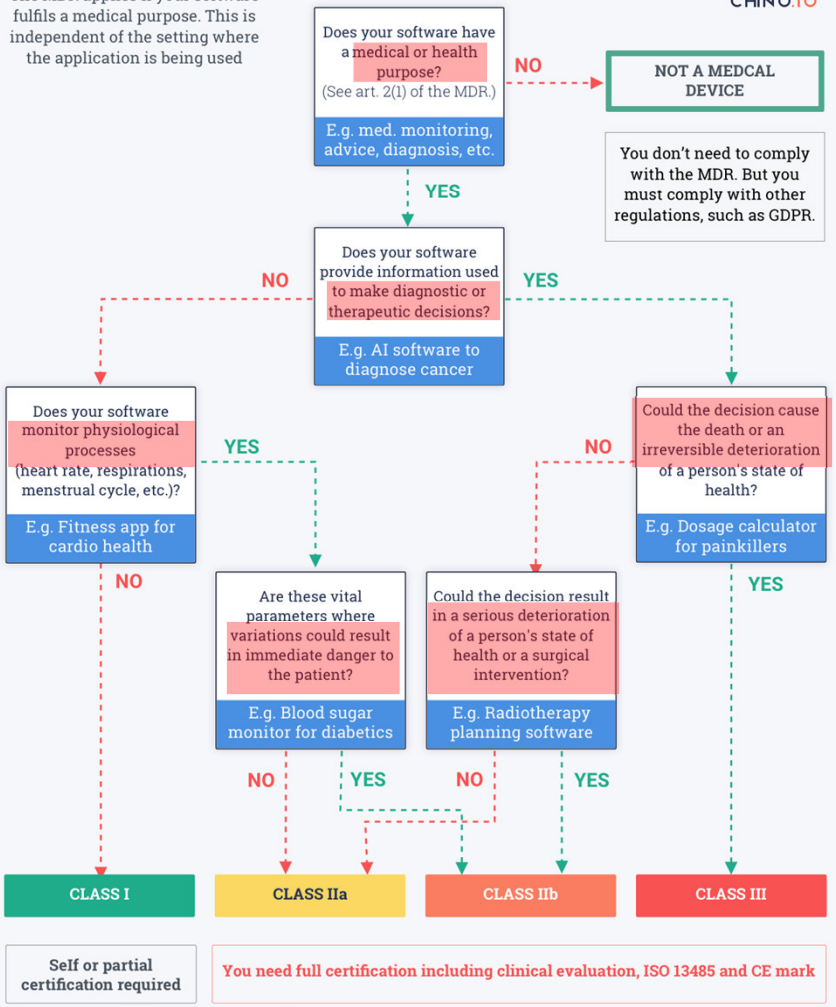
• Criticality of context	• Significance of information
• Critical situation or condition – where accurate and/or timely diagnosis or treatment action is vital to avoid death, long-term disability or other serious deterioration of health of an individual patient or to mitigating impact to public health. • Serious situation or condition – where accurate diagnosis or treatment is of vital importance to avoid unnecessary interventions • Non-Serious situation or condition – where an inaccurate diagnosis and treatment is important but not critical for interventions	• To treat or to diagnose – To provide therapy to a human body; – To diagnose/screen/detect a disease or condition • To drive clinical management – To aid in treatment by providing enhanced support to safe and effective use of medicinal products or a medical device. – To aid in making a definitive diagnosis. – To triage or identify early signs of a disease or conditions. • To Inform clinical management – To inform of options – To provide clinical information by aggregating relevant information

State of Healthcare Situation or Condition	Significance of Information Provided by SaMD to Healthcare Decision		
	Treat or Diagnose	Drive Clinical Management	Inform Clinical Management
Critical	IV	III	II
Serious	III	II	I
Non-Serious	II	I	I

What MDR class is my software?

CHINO.IO

The MDR applies if your software fulfils a medical purpose. This is independent of the setting where the application is being used



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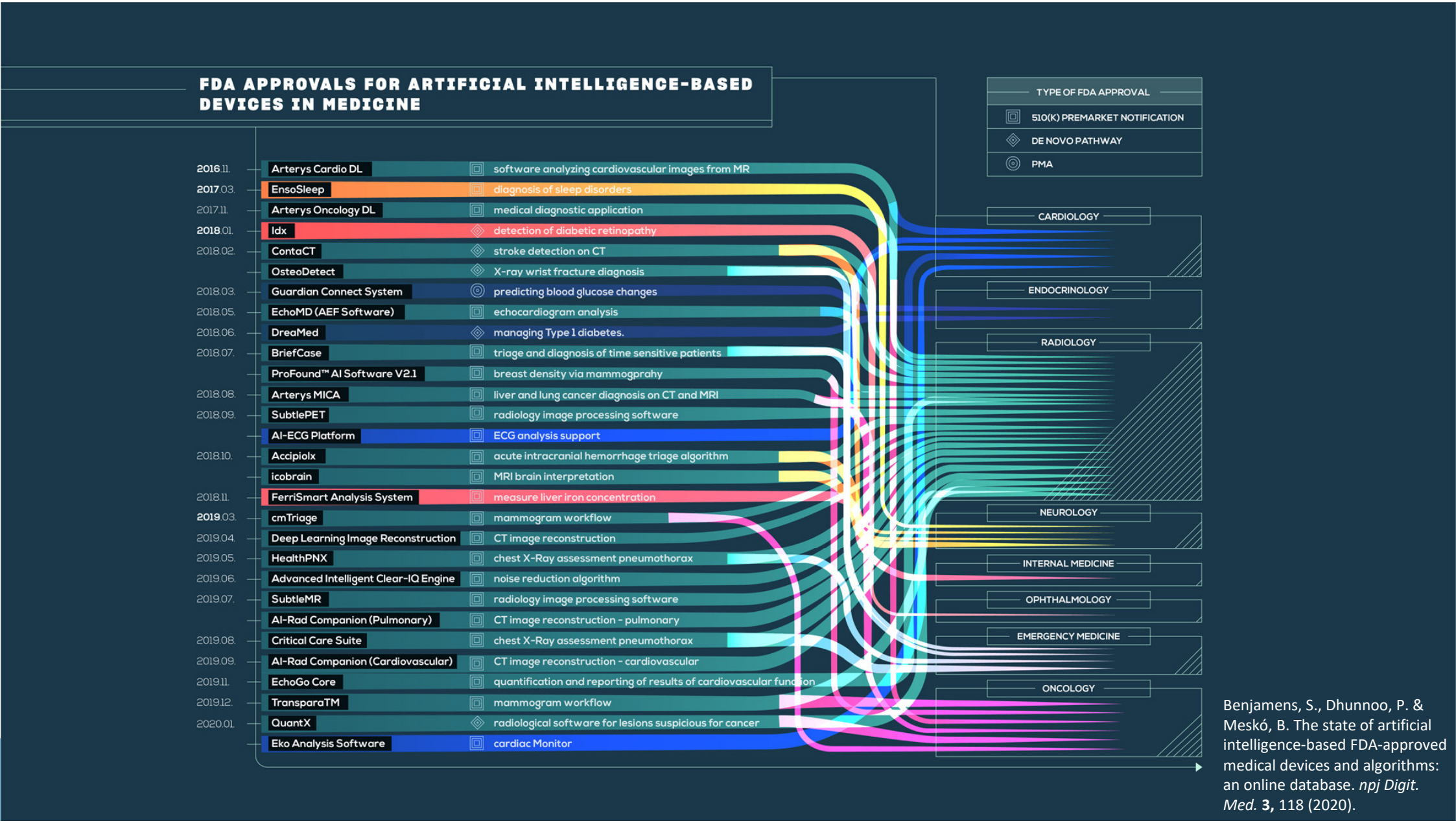


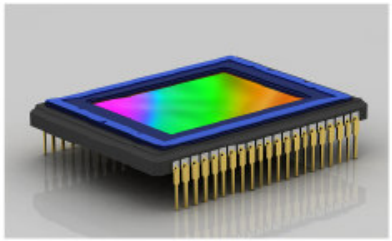
Benjamens, S., Dhunnoo, P. & Meskó, B. The state of artificial intelligence-based FDA-approved medical devices and algorithms: an online database. *npj Digit. Med.* **3,** 118 (2020).

Navigating AI Use Cases in Healthcare

THE MEDICAL FUTURIST

FROM HYPE TO EVIDENCE,
FROM SPECULATION TO SAFE BETS

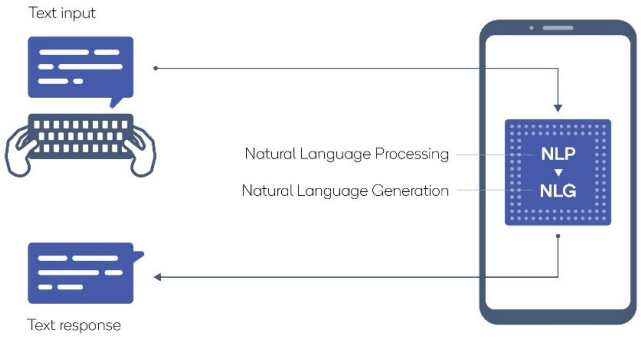
Perceptual abilities =

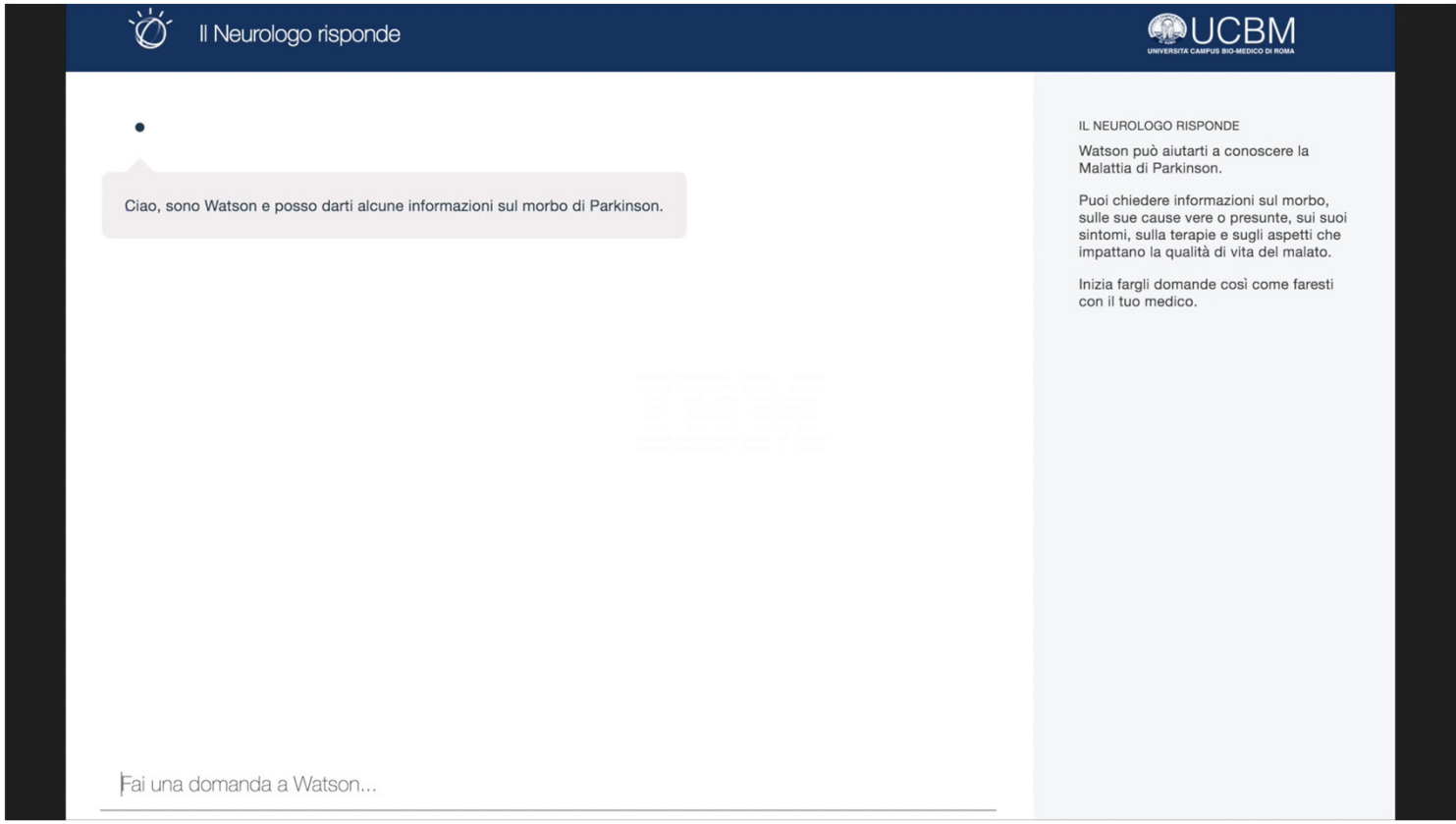
	Detection (information gathering)	+	Cognition (information processing)
Humans	 Sensory receptors		 Brain
Machines	  Sensors		 AI and other information systems

TELE CONSULT

TELECONSULT: CHATBOT

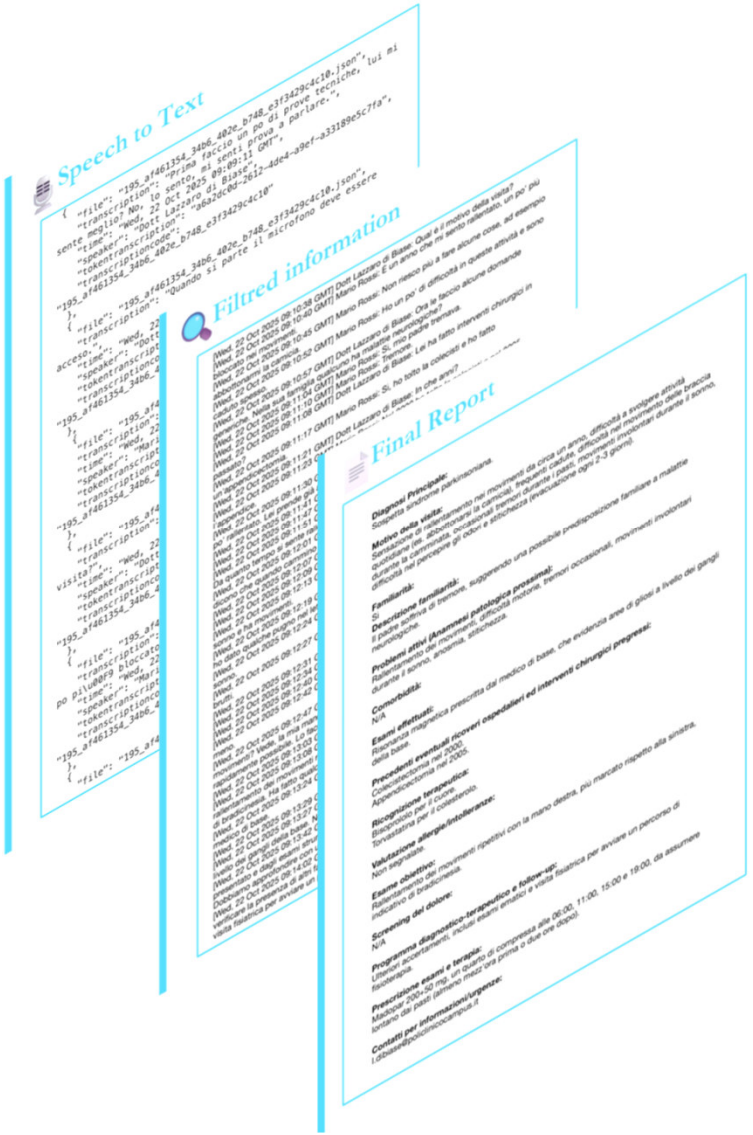
Text-based personal assistant





Televisit

AI
Automatic medical report



Parkinson’s disease

MISDIAGNOSIS

One diagnosis out three is wrong

800k

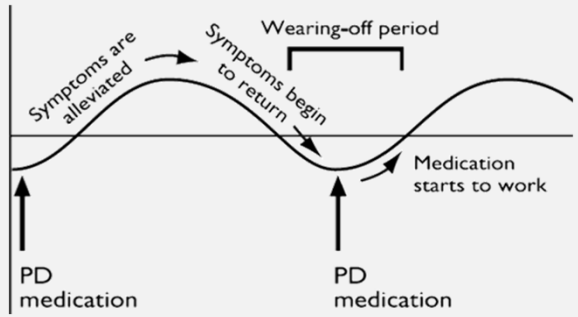
YEARLY MISDIAGNOSIS

SYMPTOMS MONITORING

No objective disease biomarkers

THERAPY MANAGEMENT

Costant fluctuation around ideal motor status



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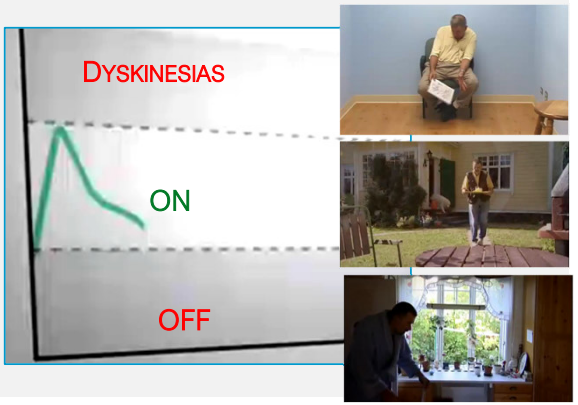

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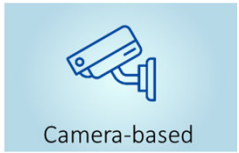
TELE DIAGNOSIS

TELE MONITORING

Computer Vision



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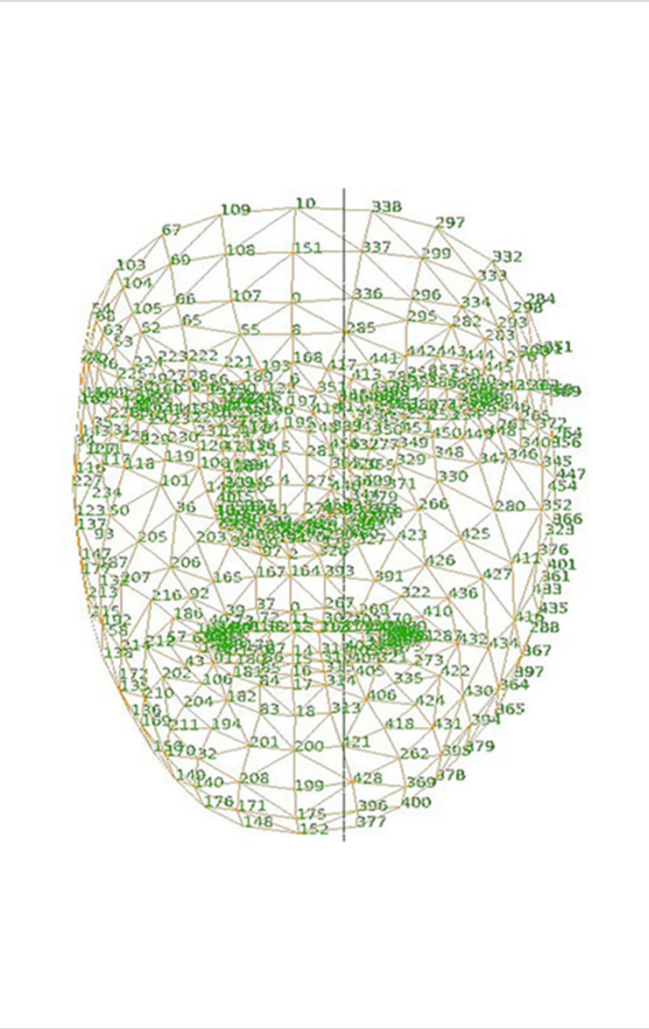

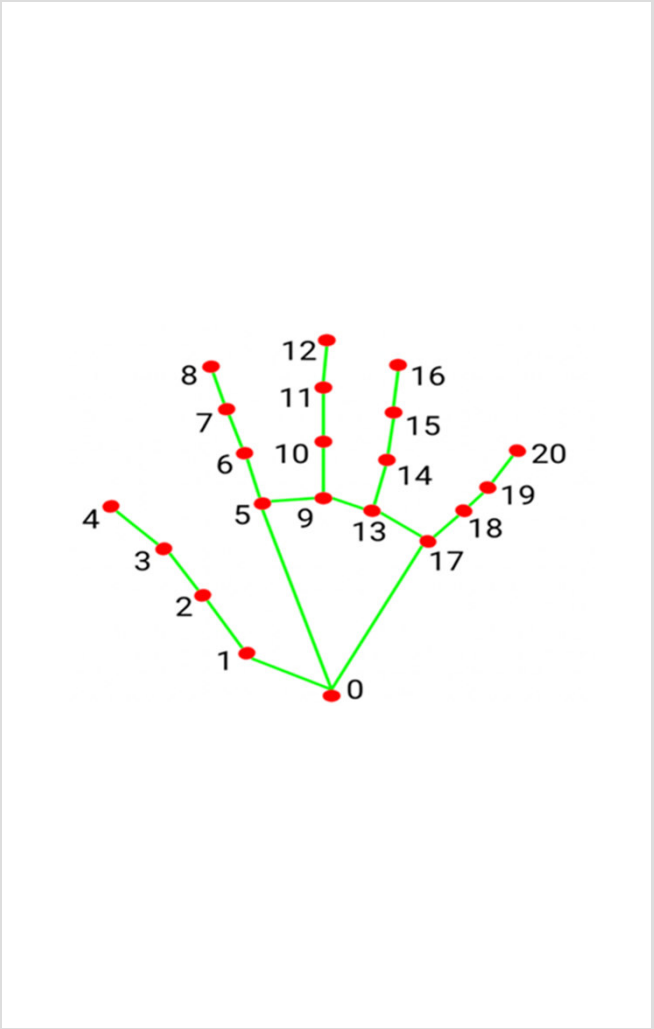
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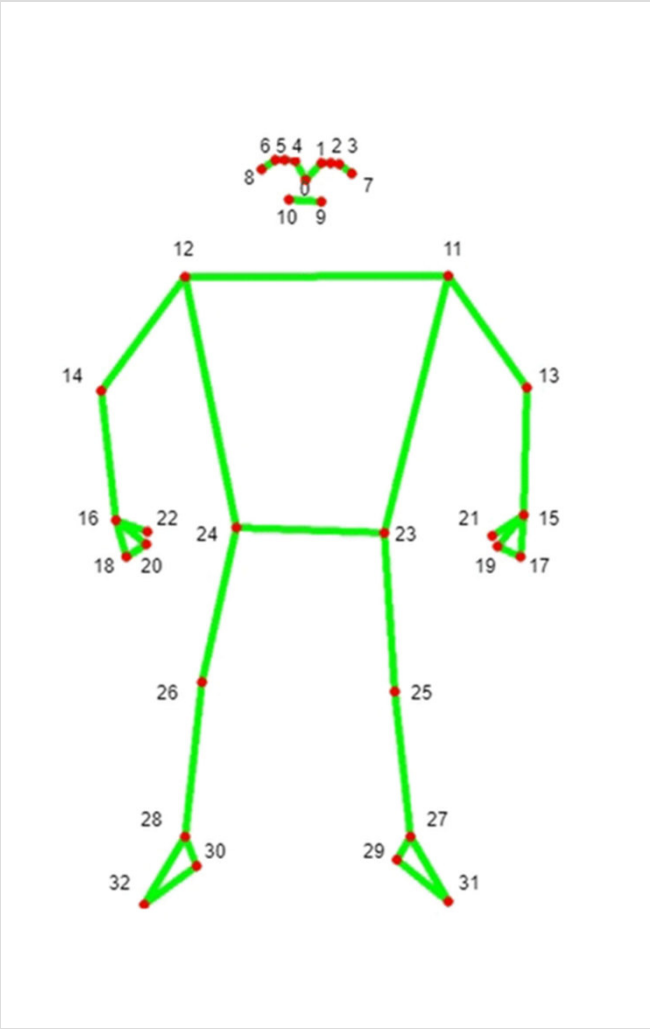
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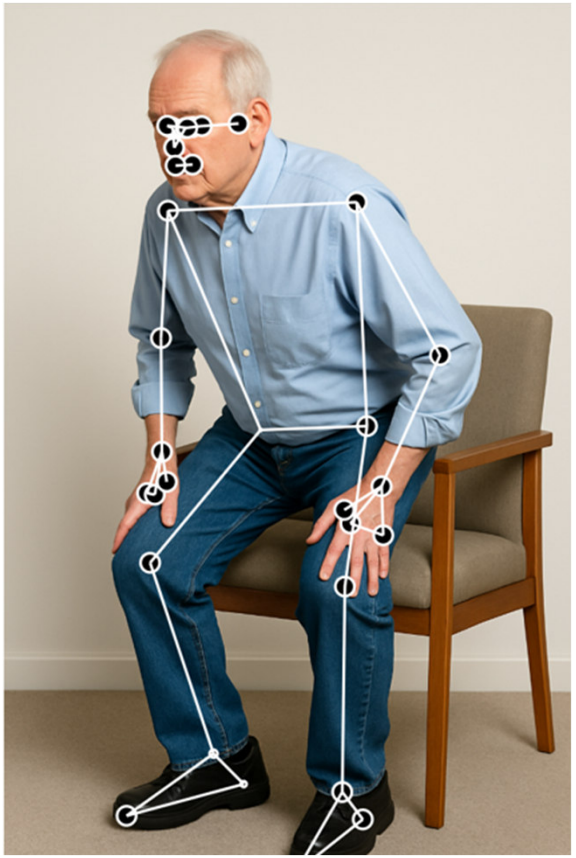
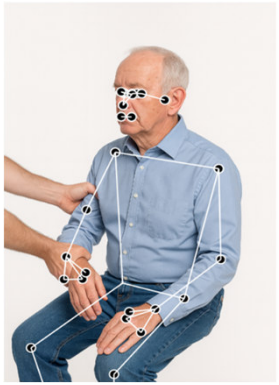
AI
Computer vision for movement analysis



MDS-UPDRS

FACE EXPRESSIONS

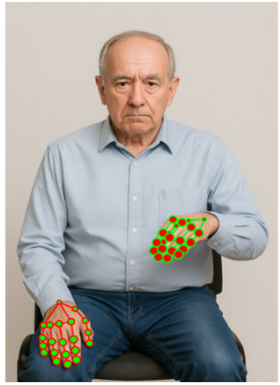
RIGIDITY



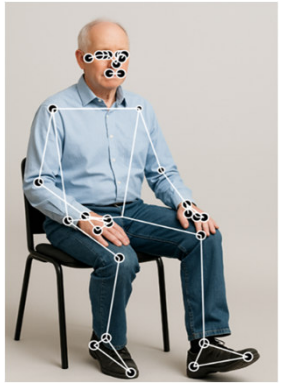
FINGER TAPPING

HAND MOVEMENTS

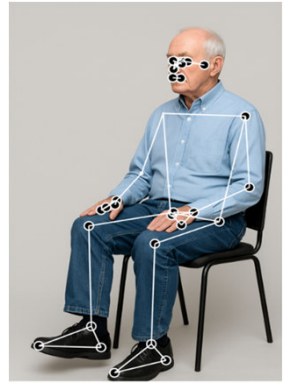
PRONOSUPINATION



TOE TAPPING



LEG AGILITY

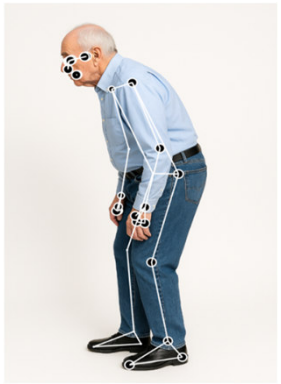


ARISING FROM A CHAIR

GAIT

POSTURAL STABILITY

POSTURE



POSTURAL TREMOR

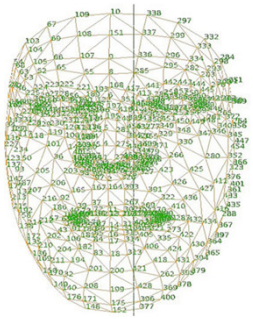
KINETIC TREMOR

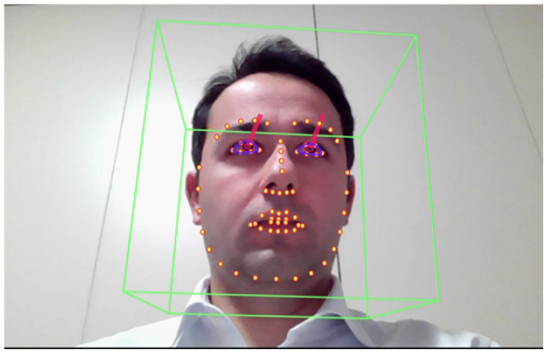
REST TREMOR

Televisit

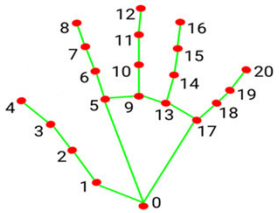
AI
Computer vision for movement analysis

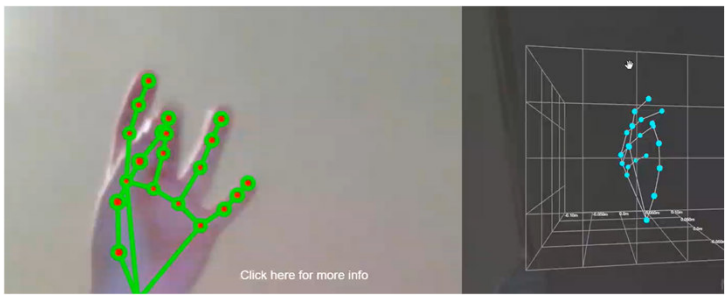
Face



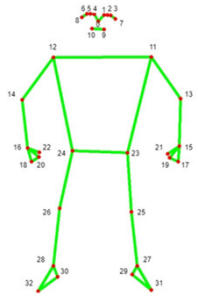


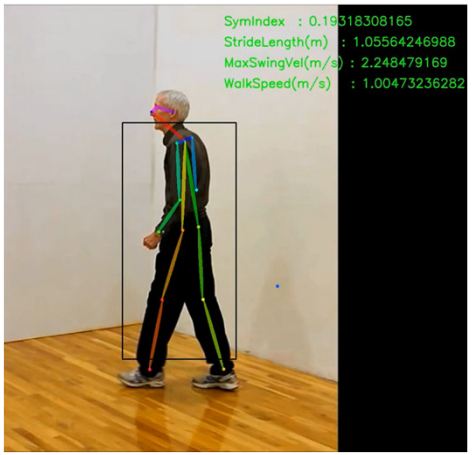
Hand



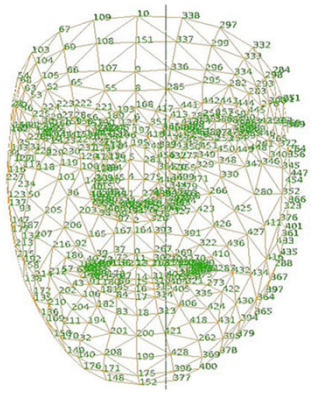


Full body

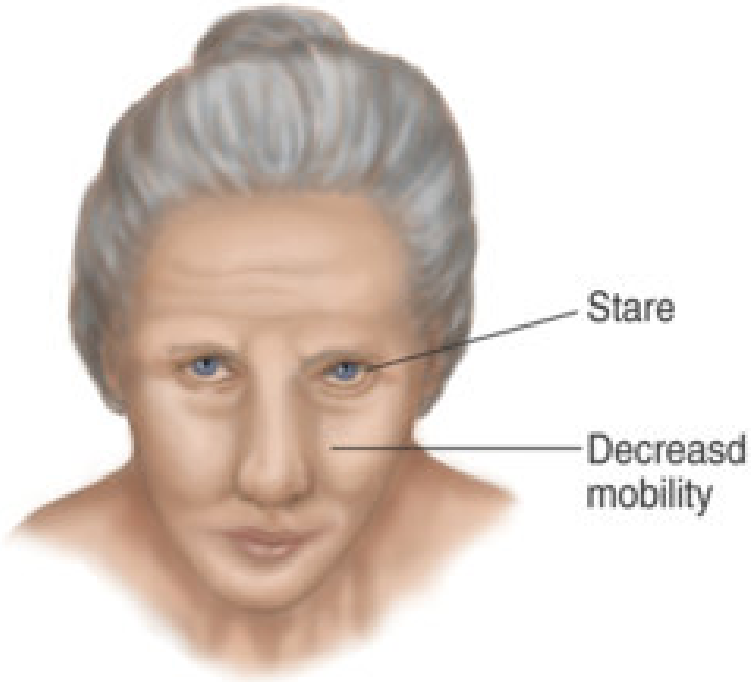


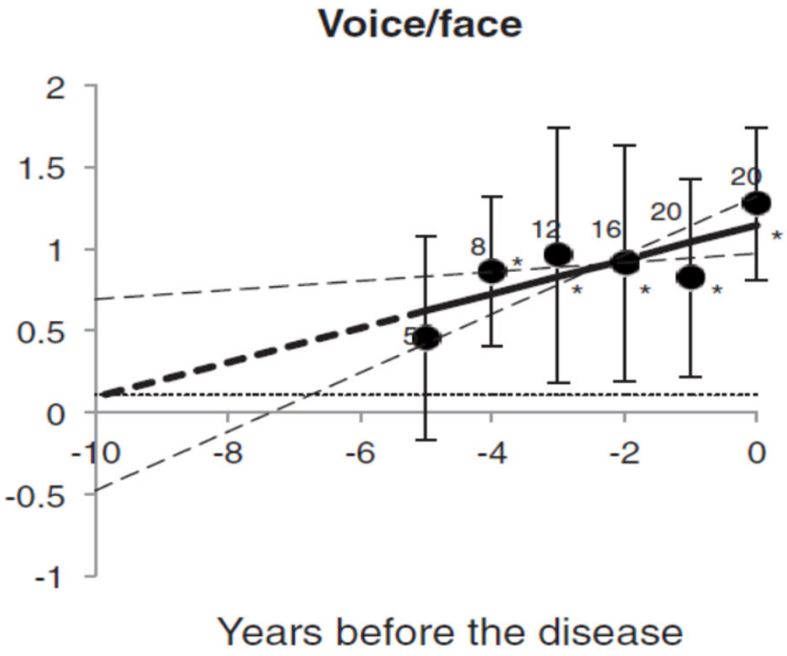


FACE Analysis



Hypomimia





(*Postuma et al., 2012*)

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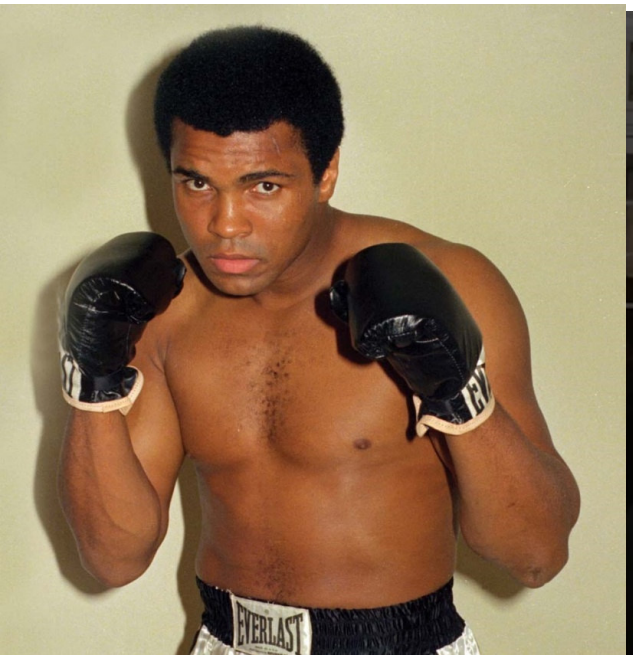
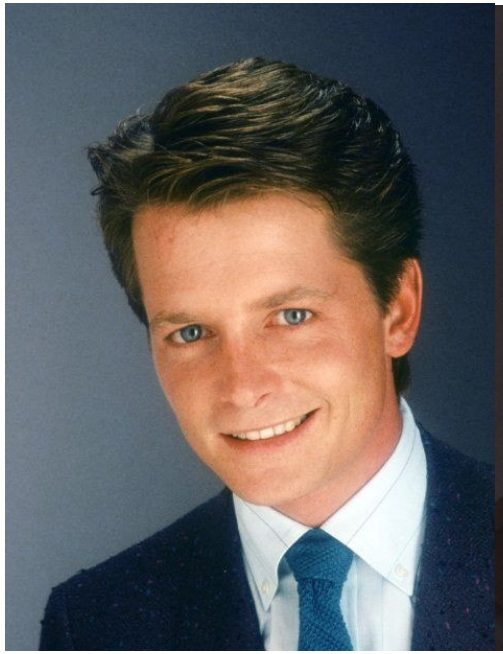
Hypomimia





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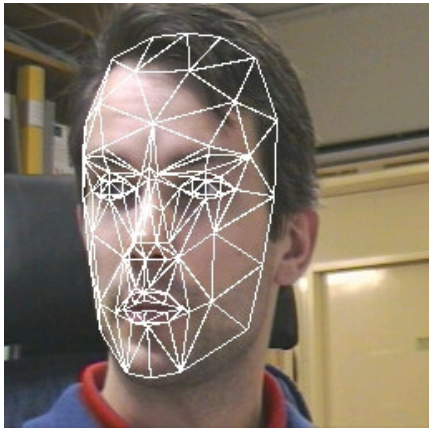
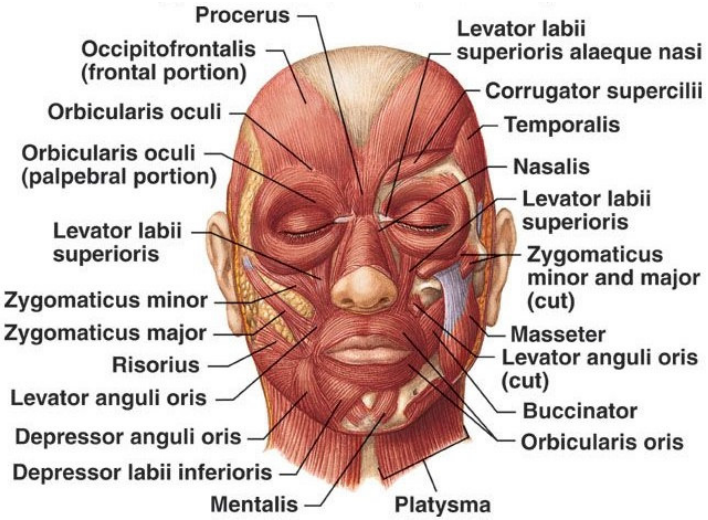
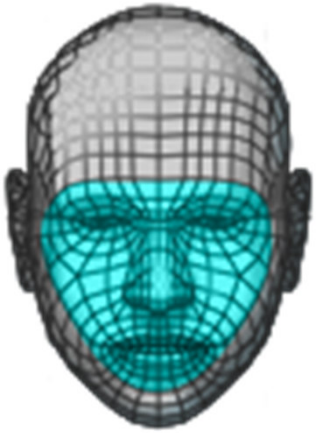
Quantitative Facial Expression Analysis





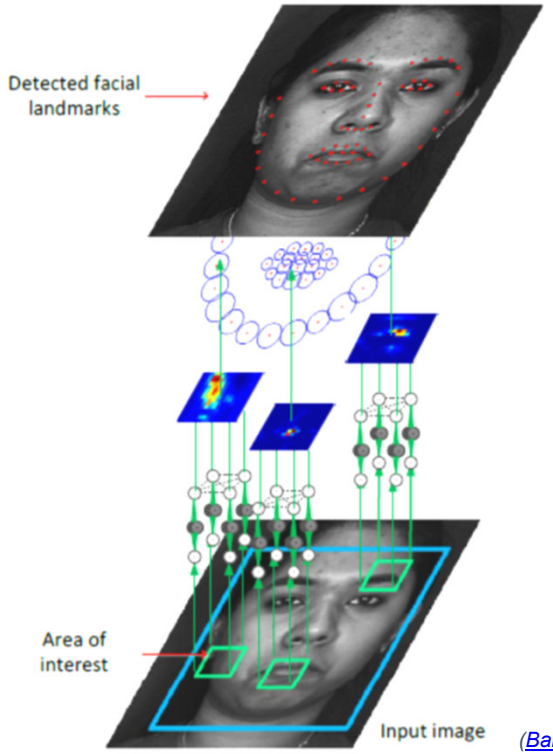
0101101

Digital data



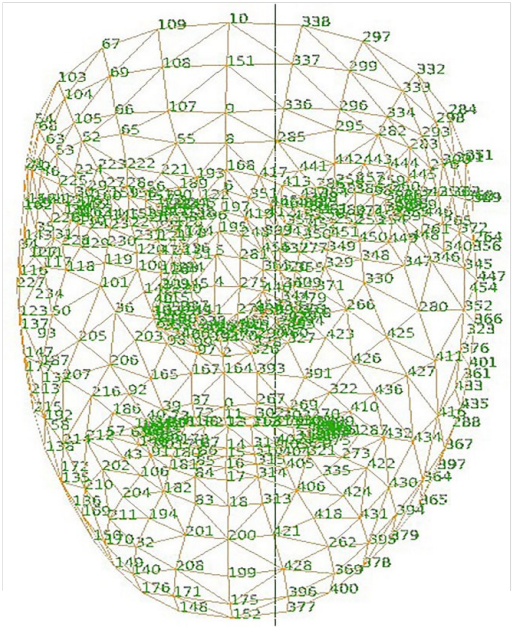
Camera-based

Facial Action Coding System (FACS)



(*Baltrusaitis* et al., *2013*)

FACE LANDMARKS



EYE LANDMARKS

(*Amos* et al., *2016*)

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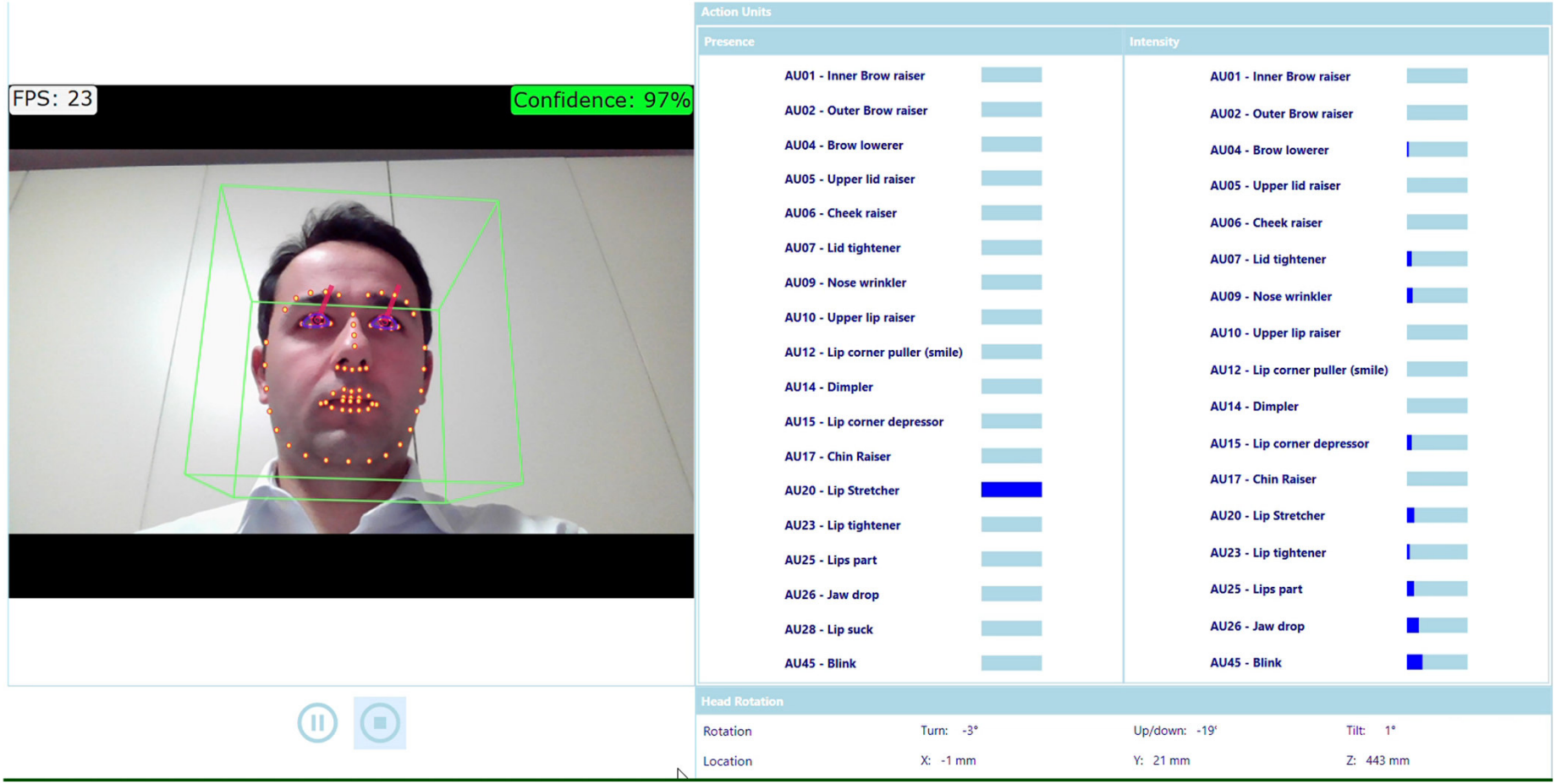
Face analysis

Camera-based



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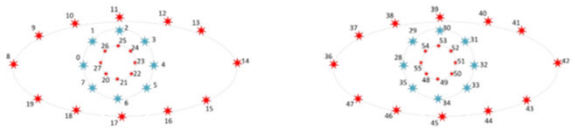
Parkinson's disease hypomimia predictor (PHP)

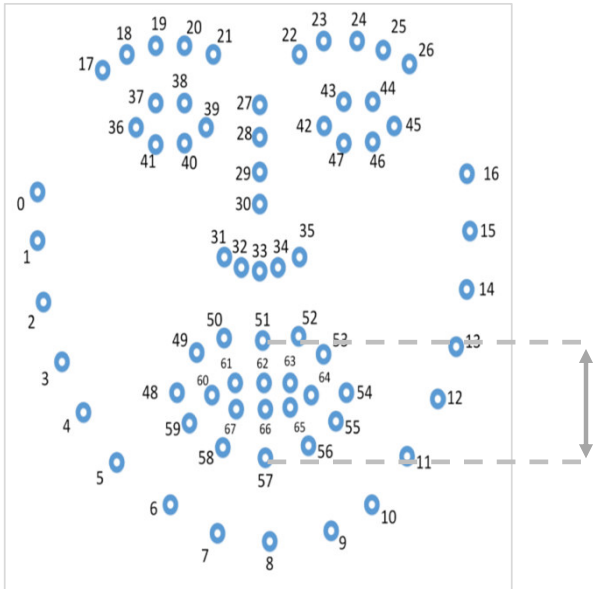
EYE LANDMARKS



Blinking intensity

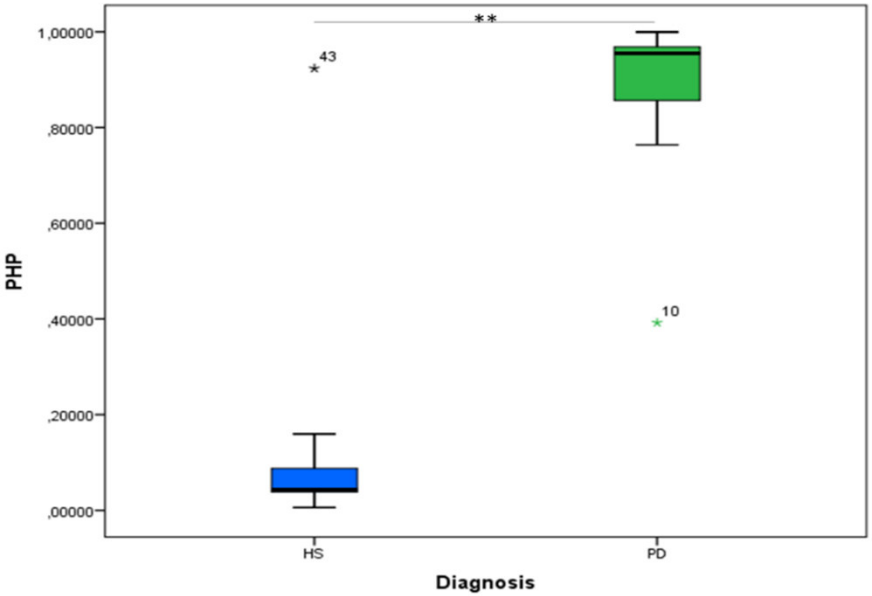
max.AU45.r: Maximum value AU45 (blink: relaxation of *levator palpebrae and contraction of orbicularis oculi, pars palpebralis*)

FACE LANDMARKS

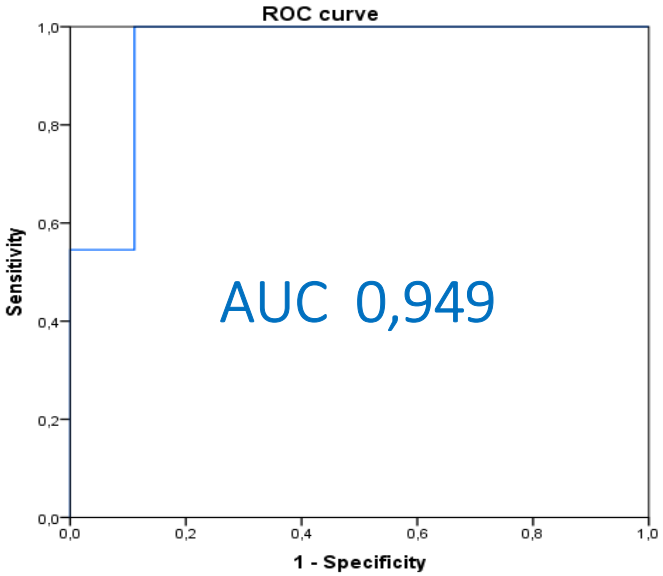


Lips distance

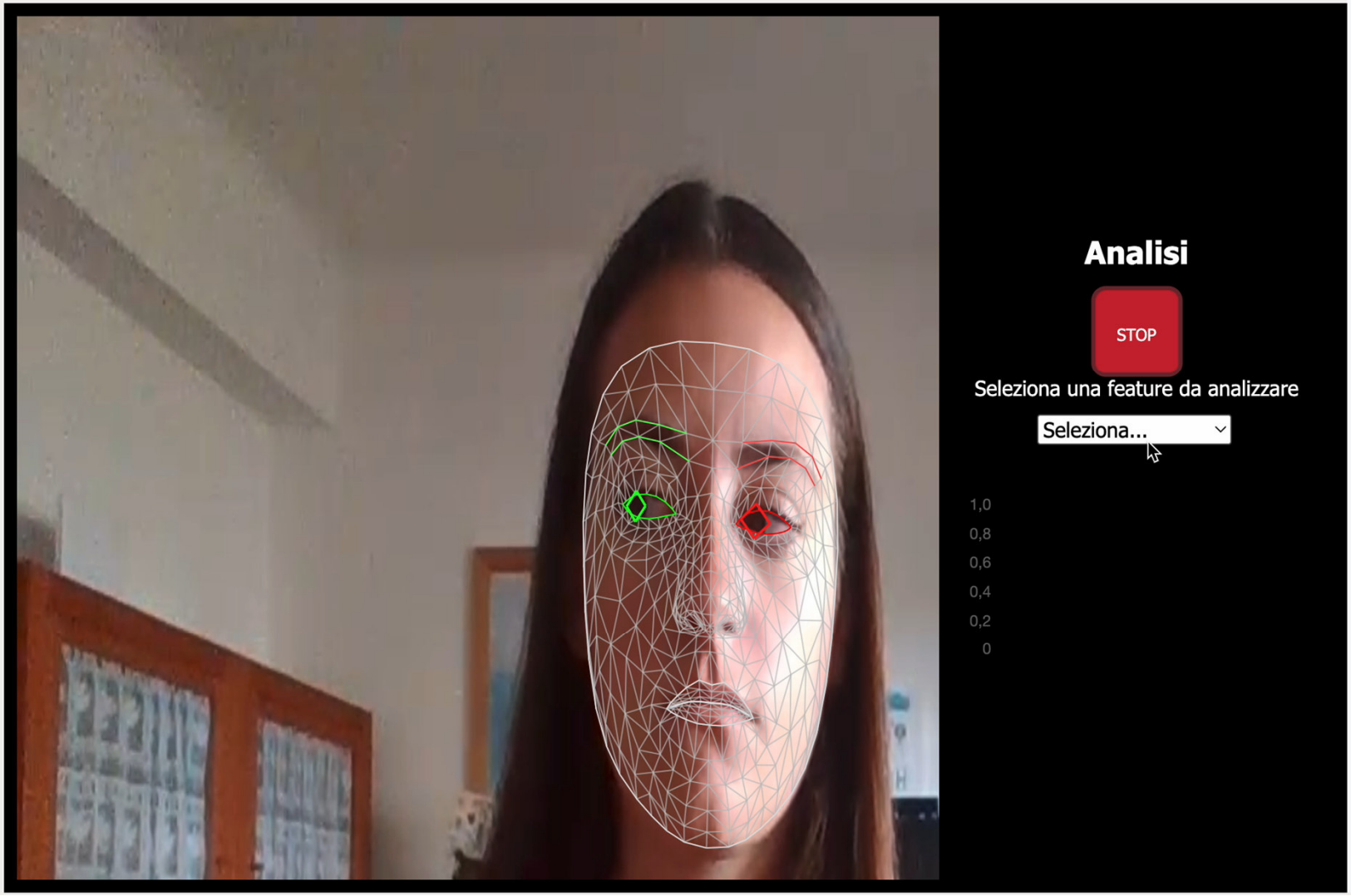
max.lips.2D.1: Maximum value between face landmarks 51 and 57



*Legend= ** : Mann–Whitney U test p<0,01*



Abbandona Video Condividi Microfono Partecipanti Chat Altro



Movement Analysis

Patients Paziente

Models

- (•) Face Model
- ( ) Pose Model
- ( ) Hand Model

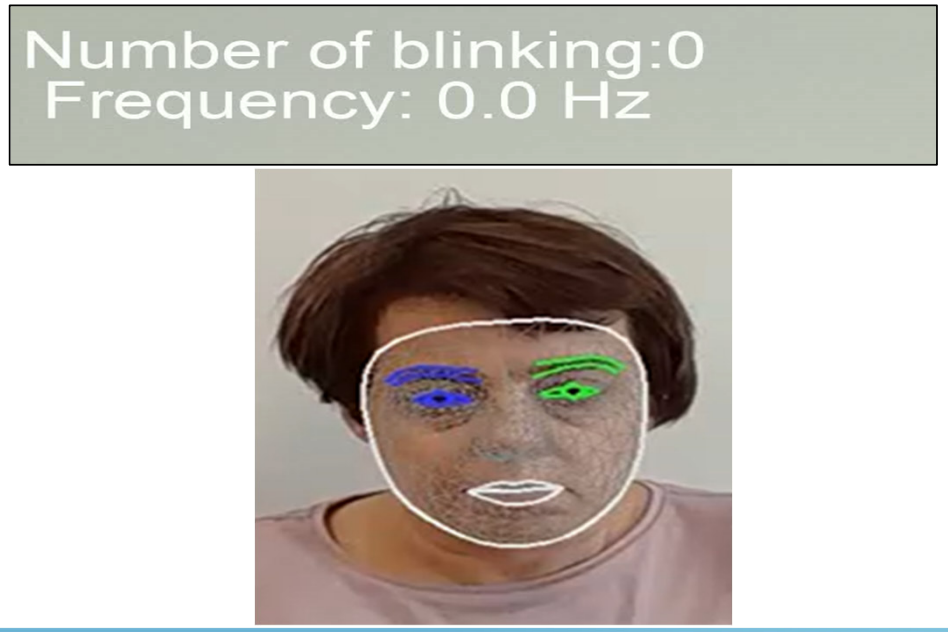
Selected Model: face

Disable analysis ✕ Close

VIDEO ANALYSIS

EYE BLINKING

ON



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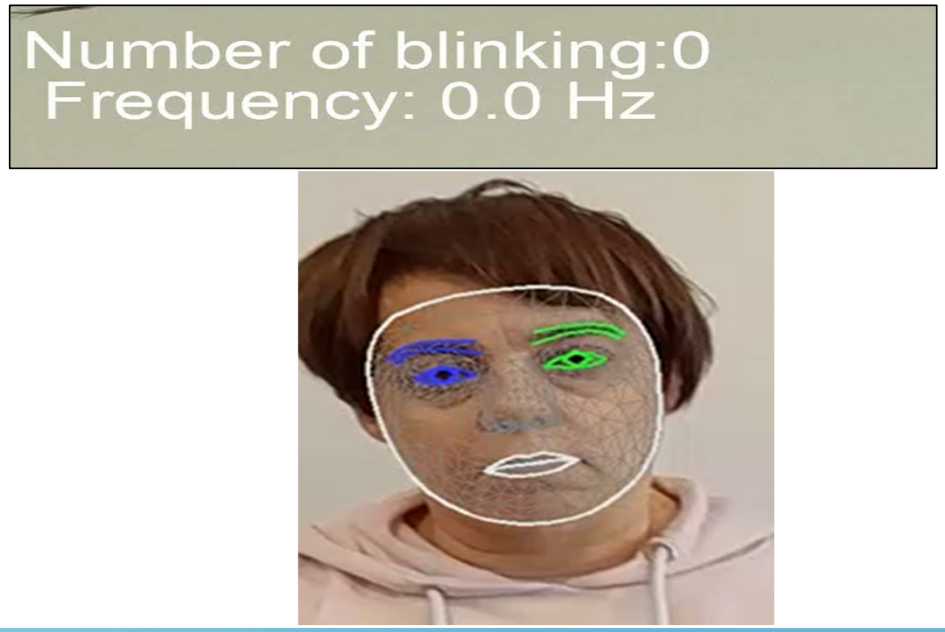
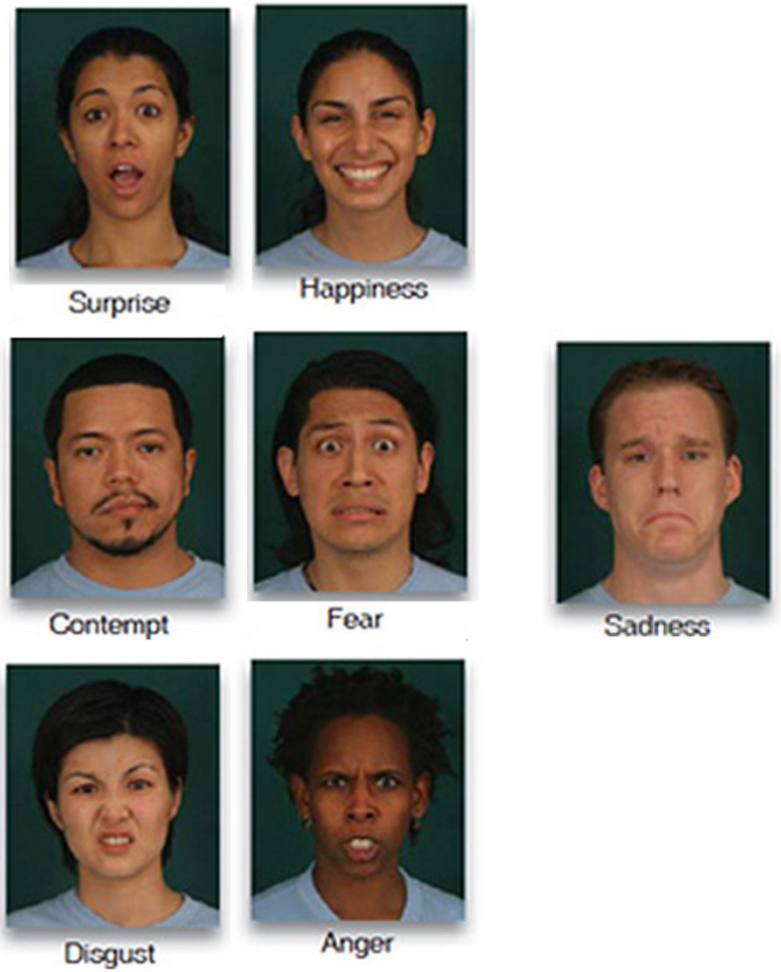
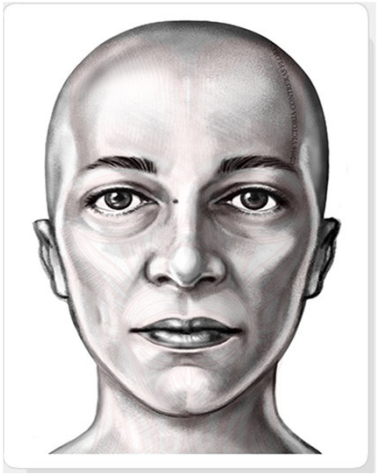
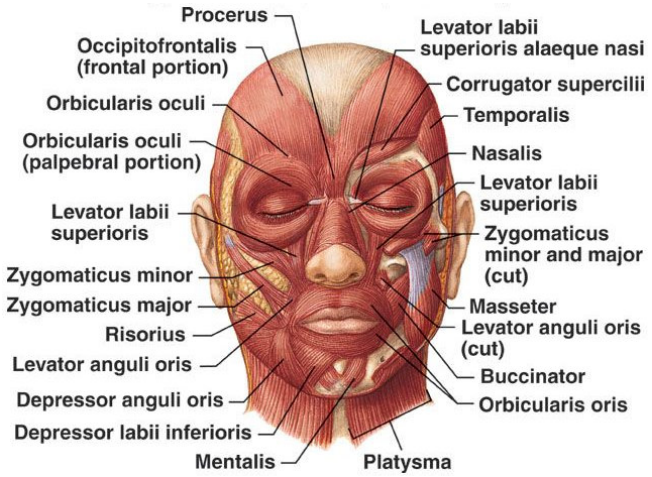


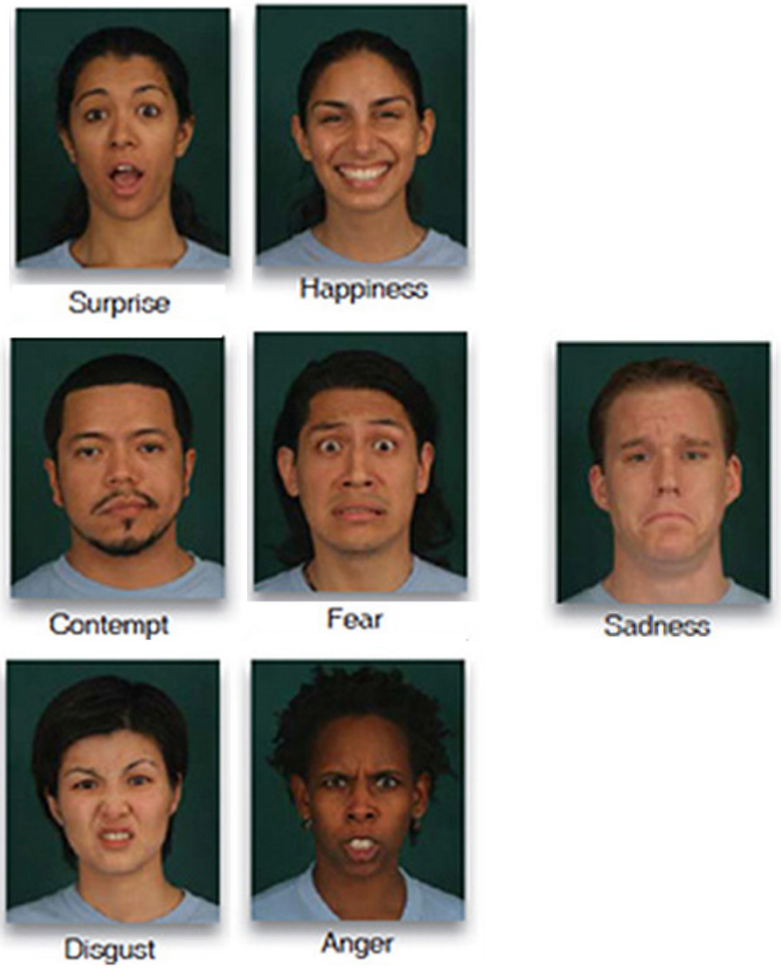
Universal Facial expressions





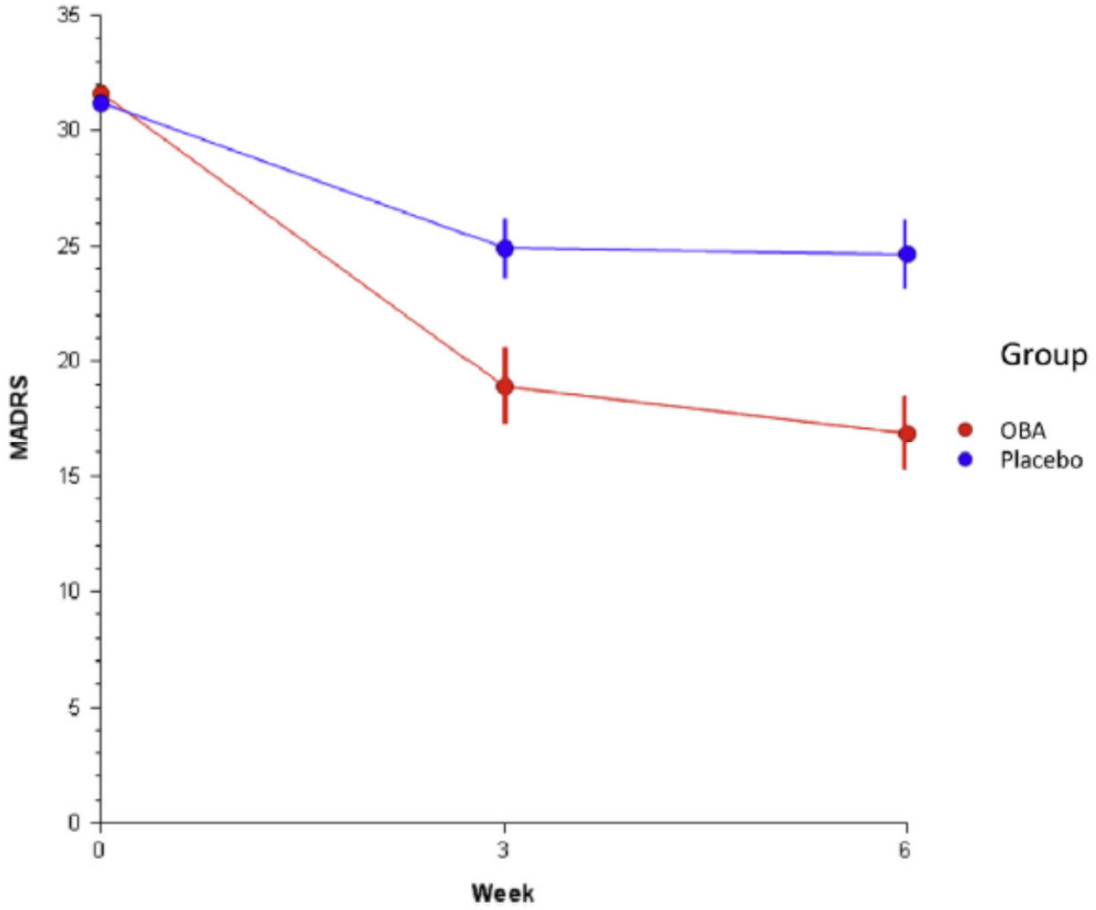


UNIVERSAL FACIAL EXPRESSIONS




4 : Brow Lowerer
Active
Inactive
Unpleasant
Pleasant
0%
20%
40%
60%
80%
100%
Neutral
Happy
Sad
Angry
Surprised
Scared
Disgusted
Contempt

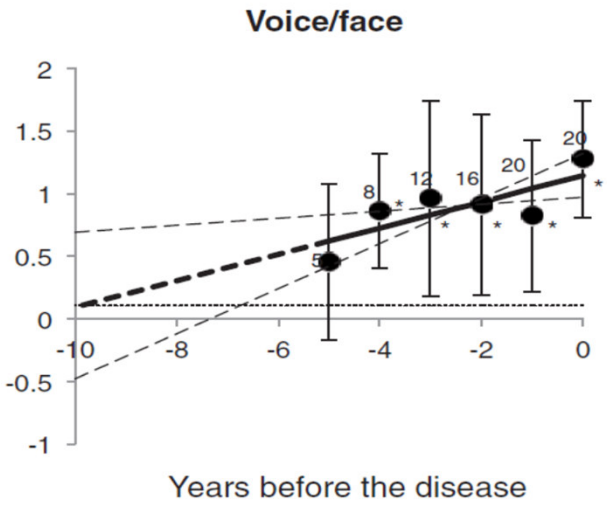
DEPRESSION



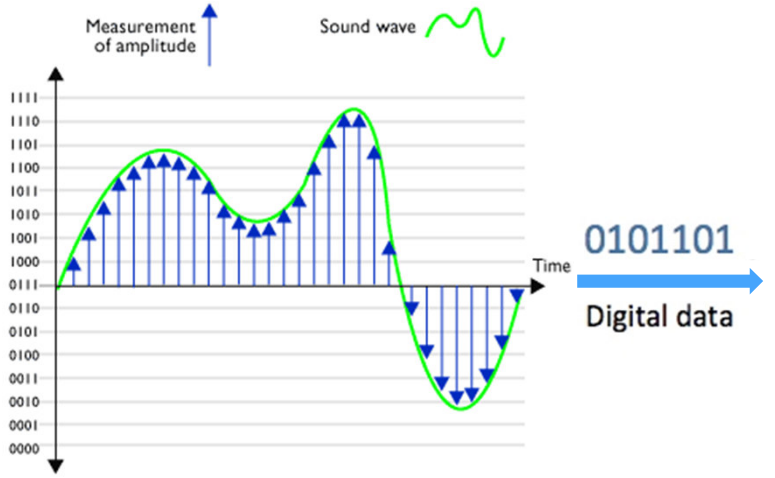
Finzi E, Rosenthal NE. Treatment of depression with onabotulinumtoxinA: a randomized, double-blind, placebo controlled trial. J Psychiatr Res. 2014

VOICE Analysis

Quantitative Speech Analysis



(*Postuma et al., 2012*)



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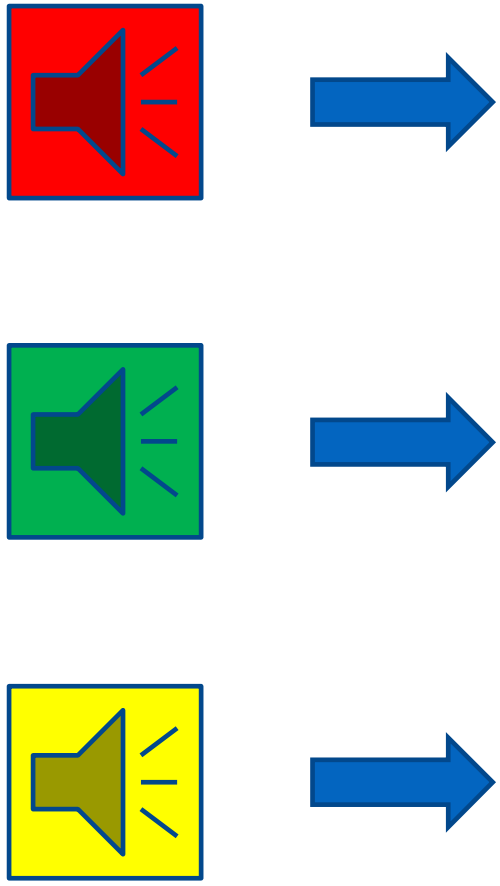
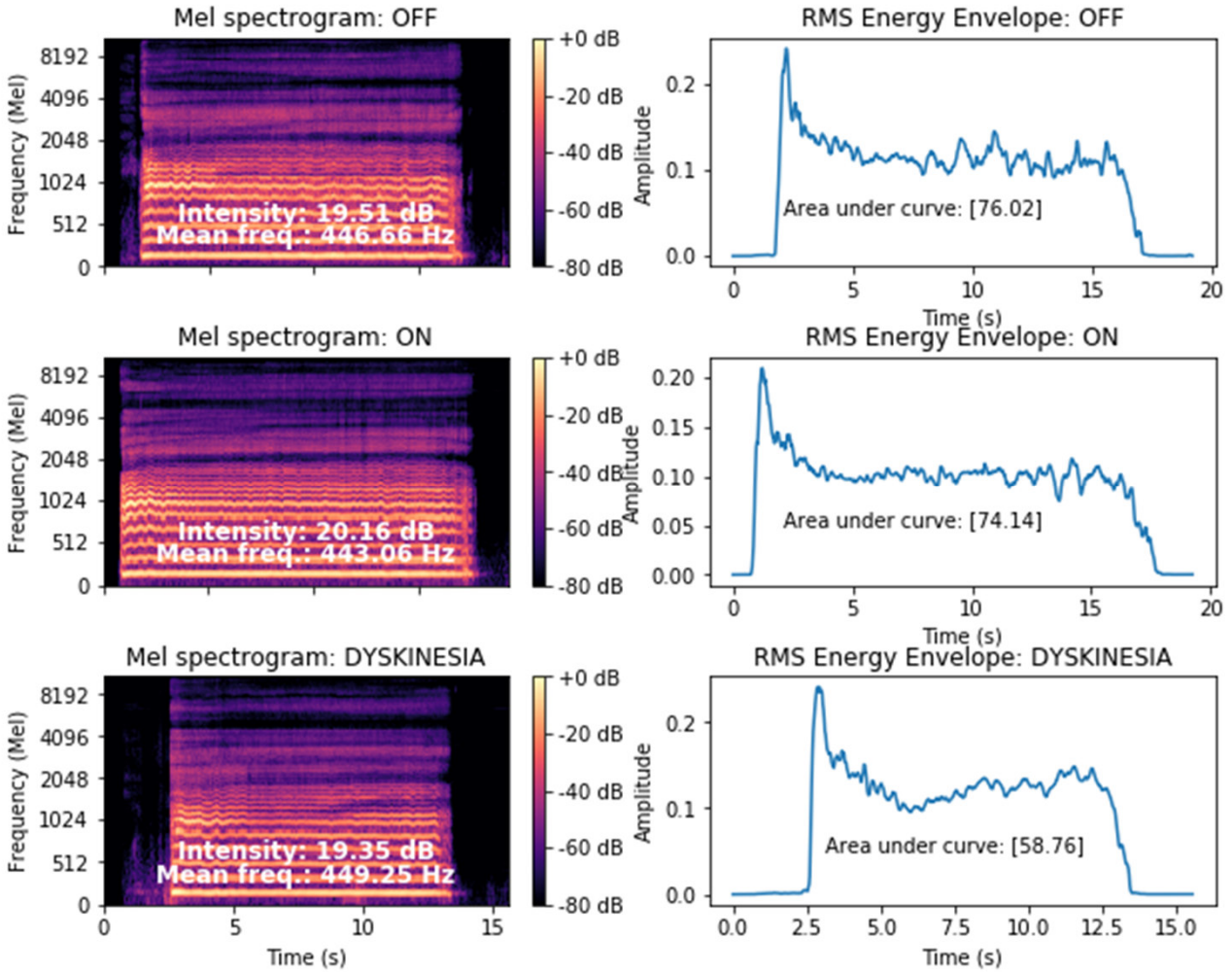
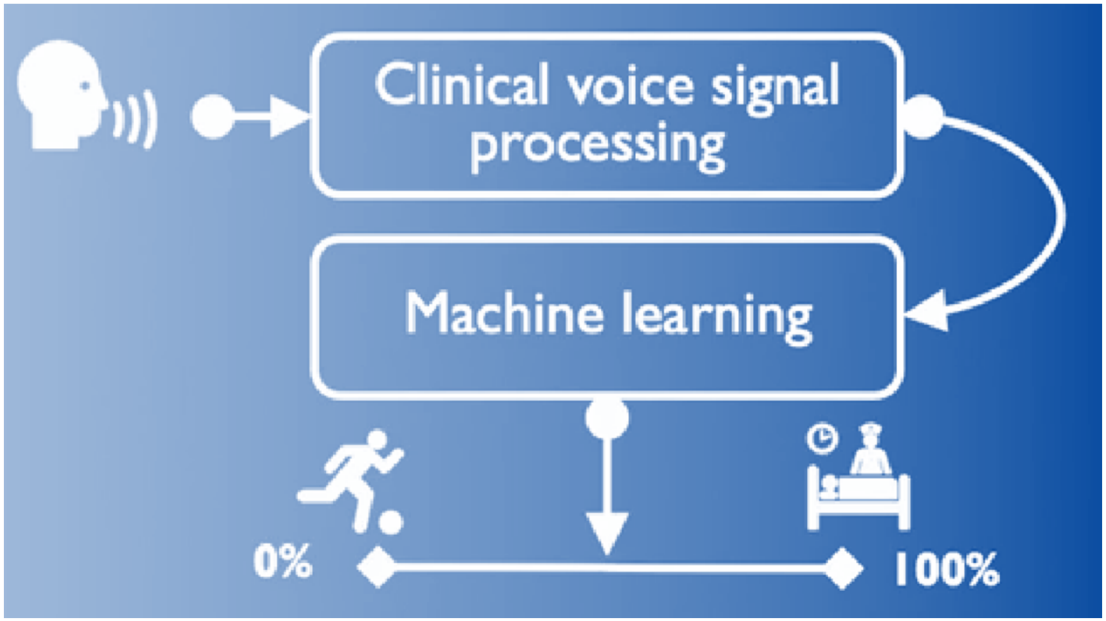
Audio analysis

Audio analysis





Quantitative Speech Analysis



MACHINE VS CLINICIANS

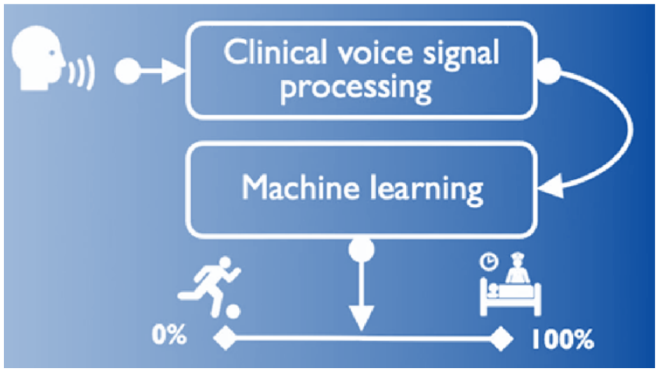
2 UPDRS points difference

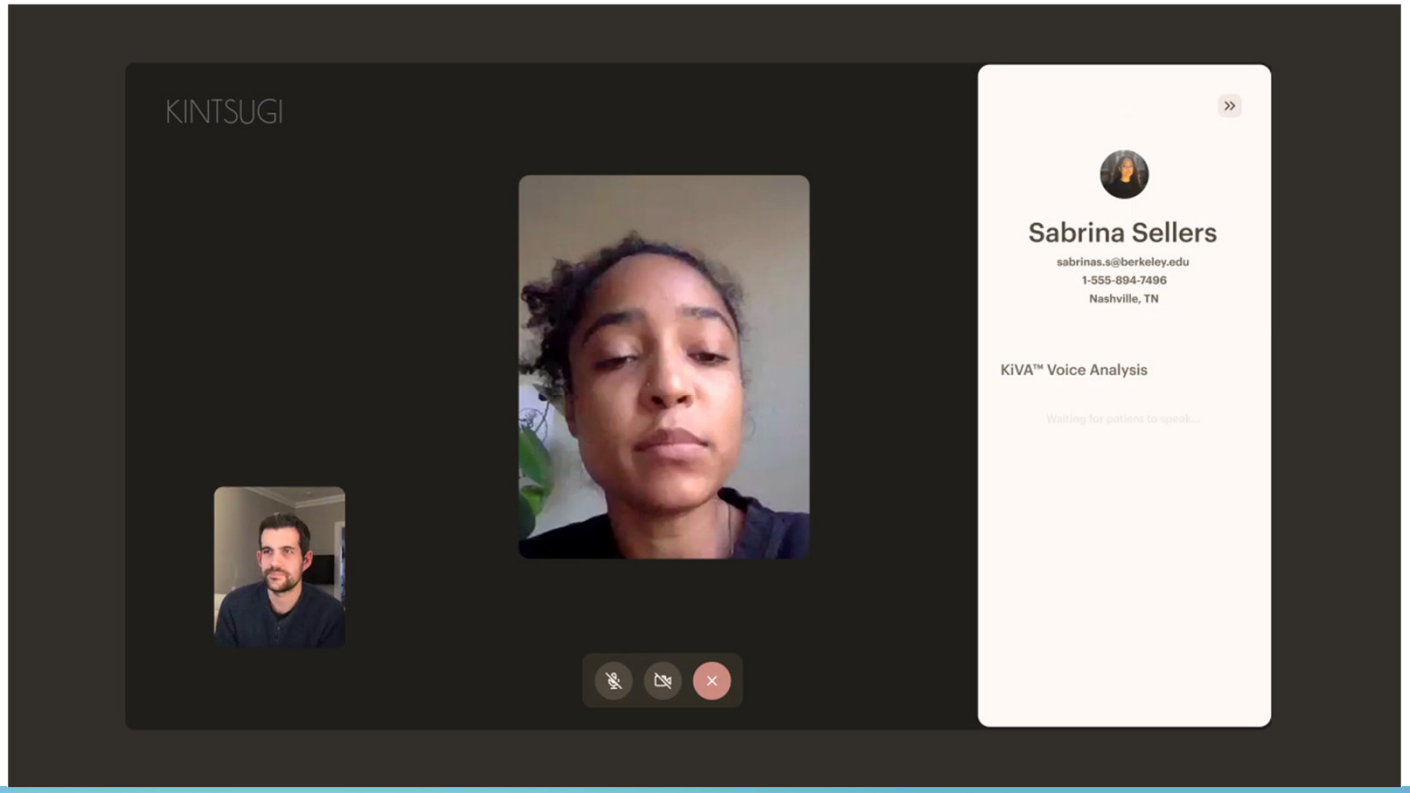
Tsanas A, J R Soc Interface. 2011 Jun 6;8(59):842-55. doi: 10.1098/rsif.2010.0456.

KINTSUGI

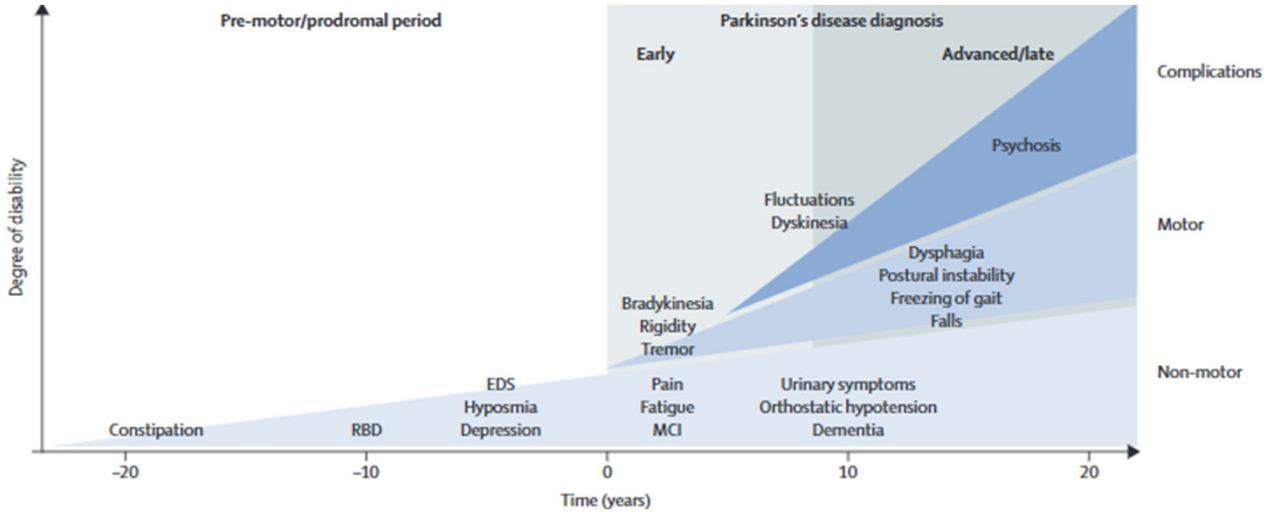
Quantitative Speech Analysis

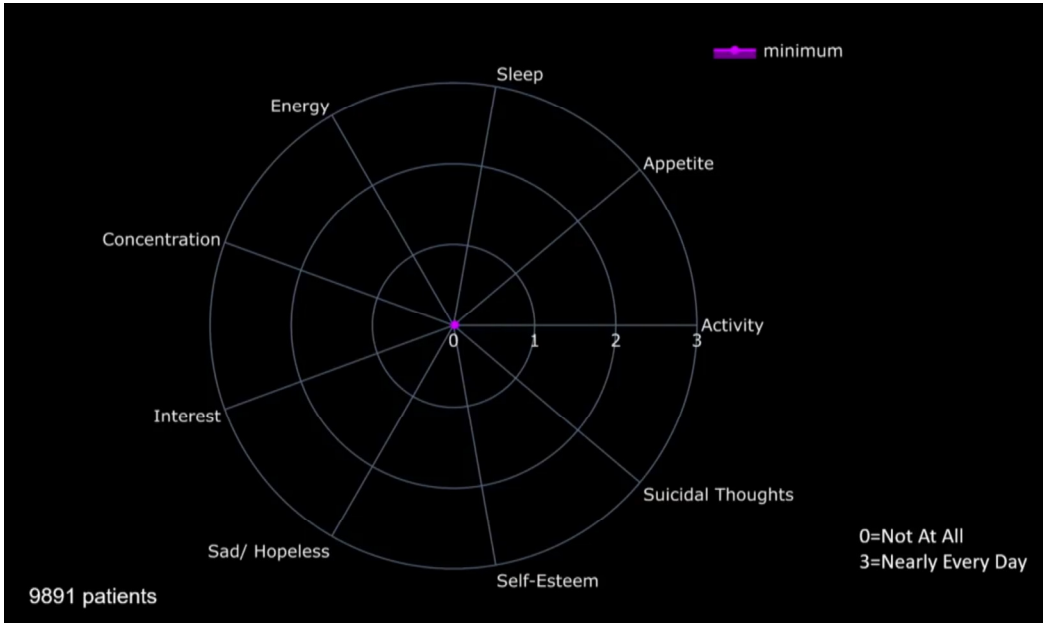
Voice biomarkers for Anxiety and Depression

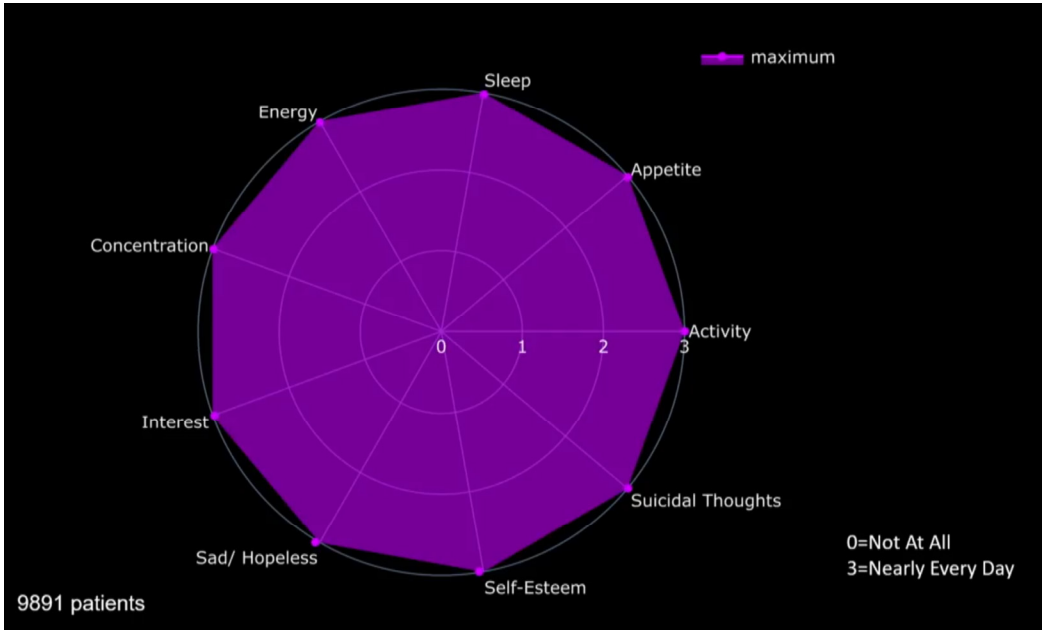




DEPRESSION


Pre-motor/prodromal period
Parkinson's disease diagnosis
Early
Advanced/late
Complications
Psychosis
Fluctuations
Dyskinesia
Motor
Dysphagia
Postural instability
Freezing of gait
Falls
Bradykinesia
Rigidity
Tremor
Non-motor
Constipation
RBD
EDS
Hyposmia
Depression
Pain
Fatigue
MCI
Urinary symptoms
Orthostatic hypotension
Dementia
Degree of disability
-20
-10
0
10
20
Time (years)


minimum
Sleep
Energy
Appetite
Concentration
Activity
0
1
2
3
Interest
Suicidal Thoughts
Sad/ Hopeless
Self-Esteem
0=Not At All
3=Nearly Every Day
9891 patients


maximum
Sleep
Energy
Appetite
Concentration
Activity
0
1
2
3
Interest
Suicidal Thoughts
Sad/ Hopeless
Self-Esteem
0=Not At All
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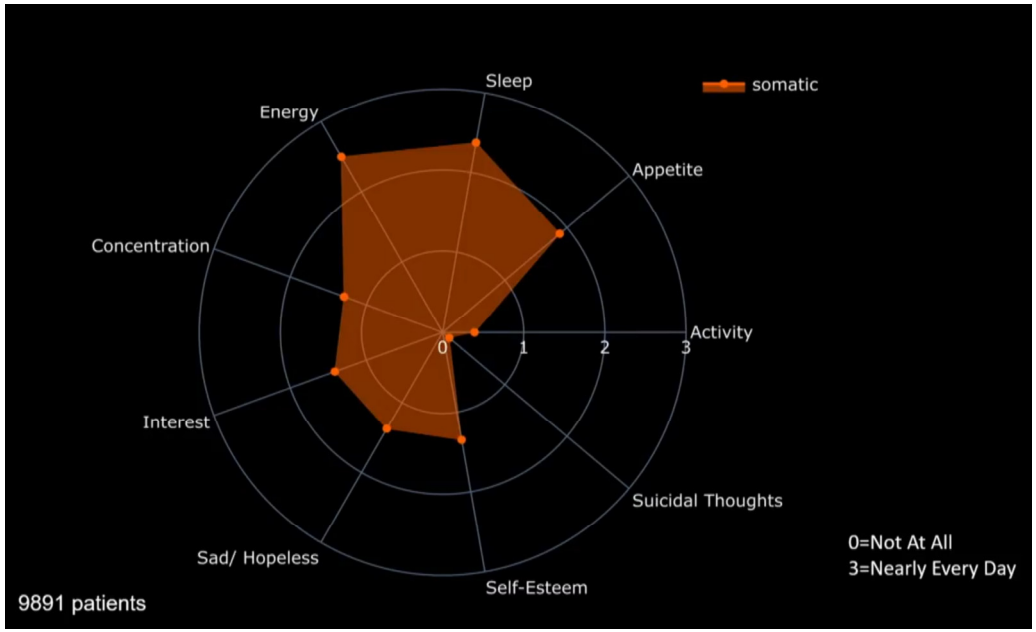
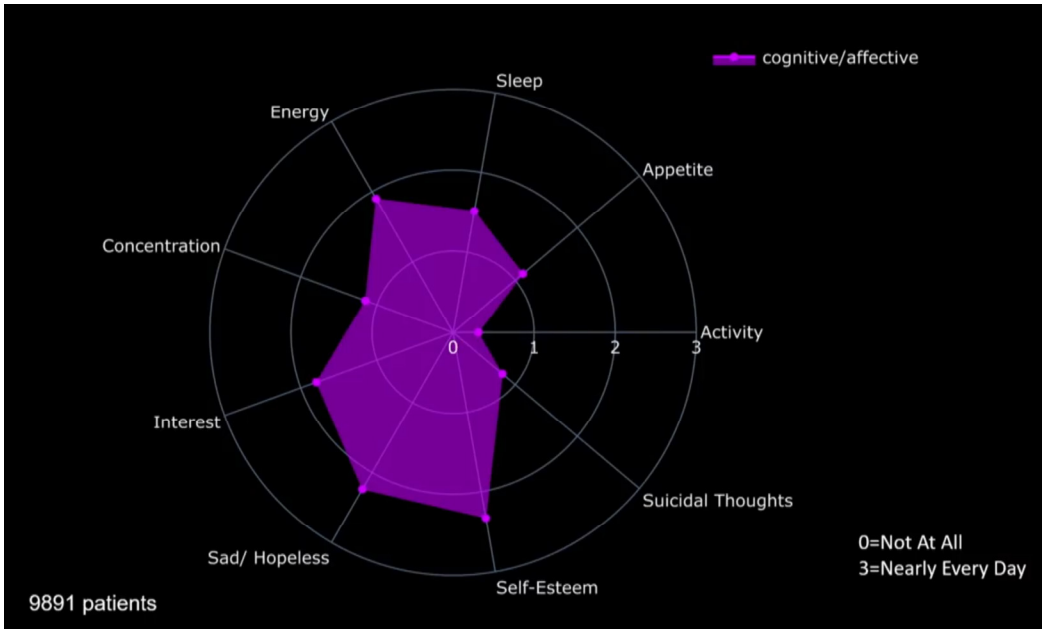
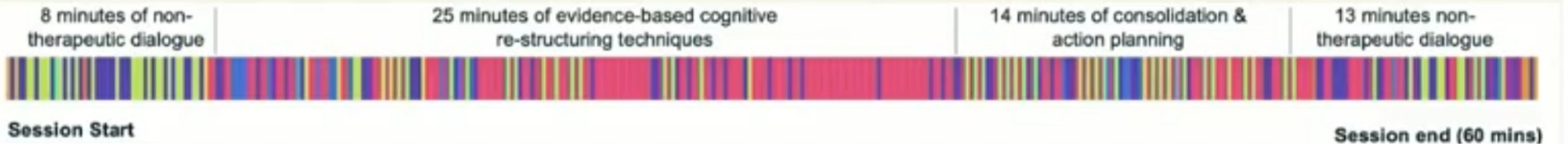

somatic
Sleep
Energy
Appetite
Concentration
Activity
0
1
2
3
Interest
Suicidal Thoughts
Sad/ Hopeless
Self-Esteem
0=Not At All
3=Nearly Every Day
9891 patients

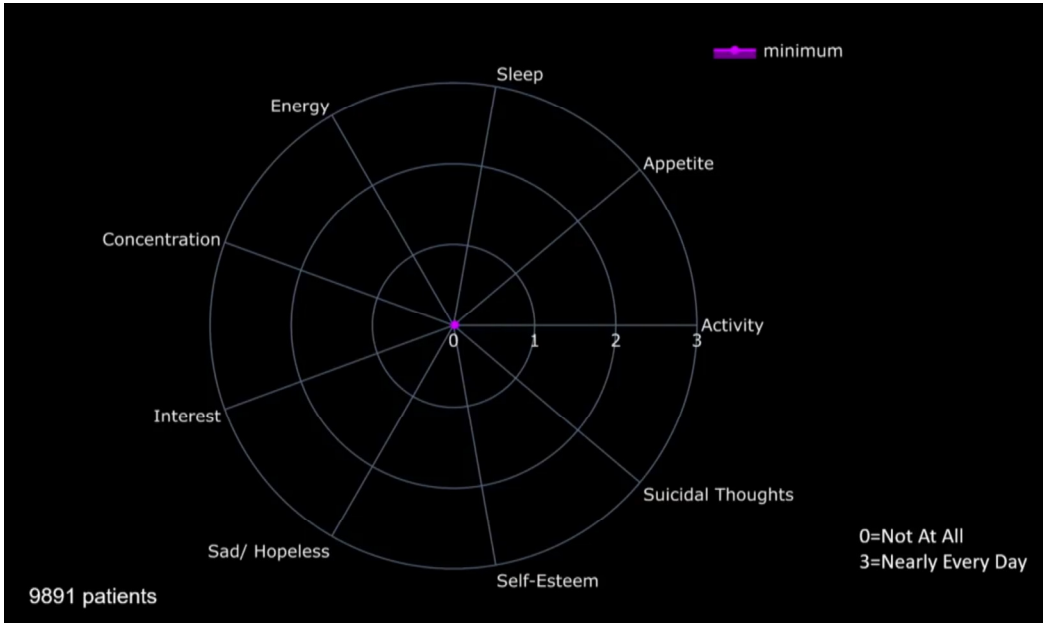

cognitive/affective
Sleep
Energy
Appetite
Concentration
Activity
0
1
2
3
Interest
Suicidal Thoughts
Sad/ Hopeless
Self-Esteem
0=Not At All
3=Nearly Every Day
9891 patients

Telehealthcare Platforms Can be Used to Collect Decision-Action-Outcomes Data at Scale

Generate Data
Learn What Works
Provide Insight



JAMA Psychiatry
doi:10.1001/jamapsychiatry.2019.2664


minimum
Sleep
Energy
Appetite
Concentration
Activity
0
1
2
3
Interest
Suicidal Thoughts
Sad/ Hopeless
Self-Esteem
0=Not At All
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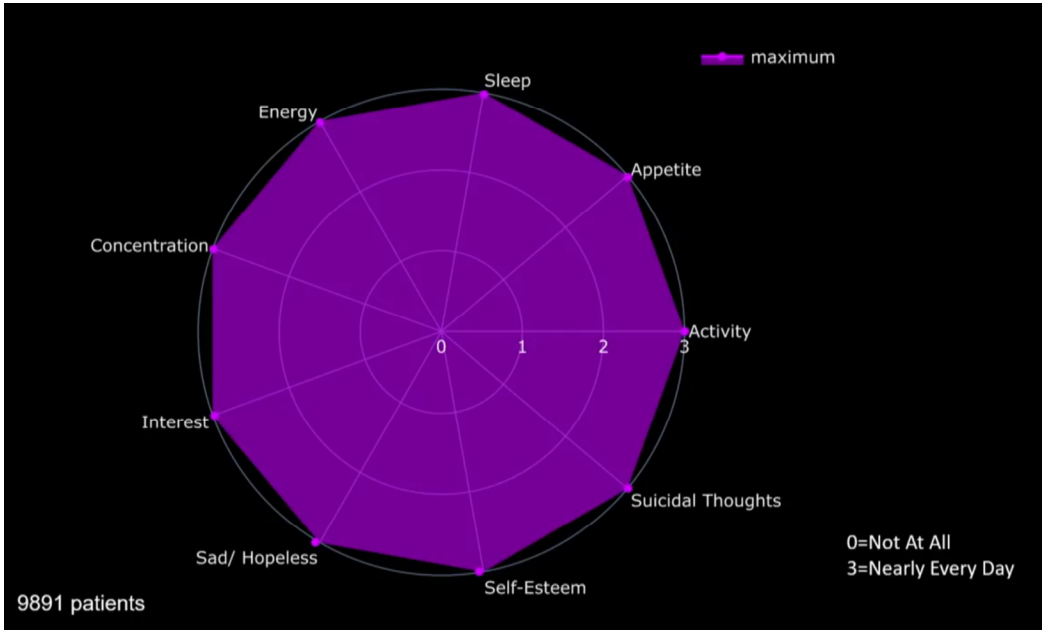
9891 patients


maximum
Sleep
Energy
Appetite
Concentration
Activity
0
1
2
3
Interest
Suicidal Thoughts
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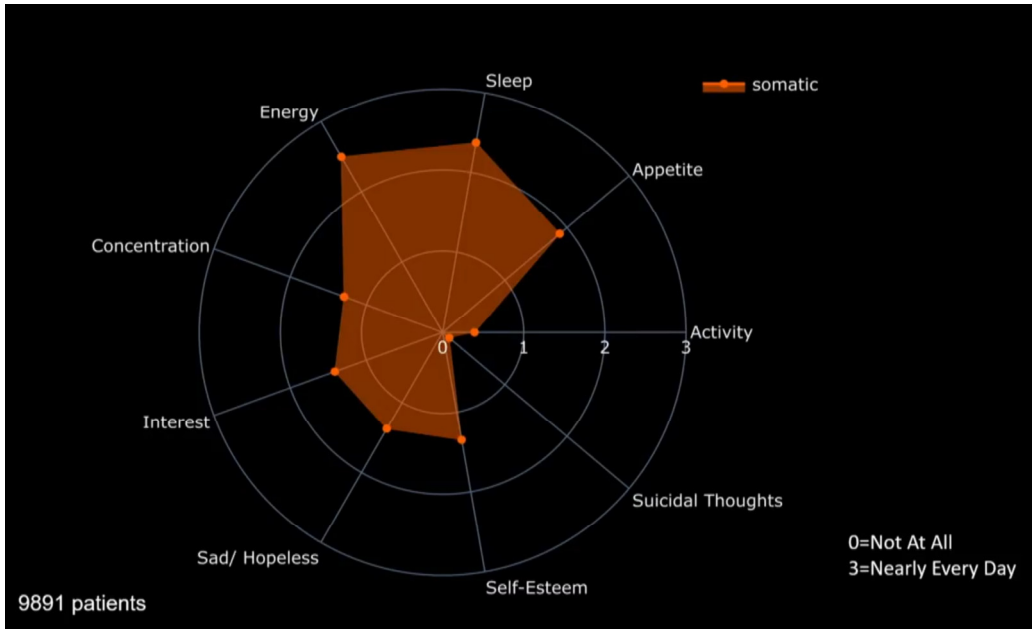
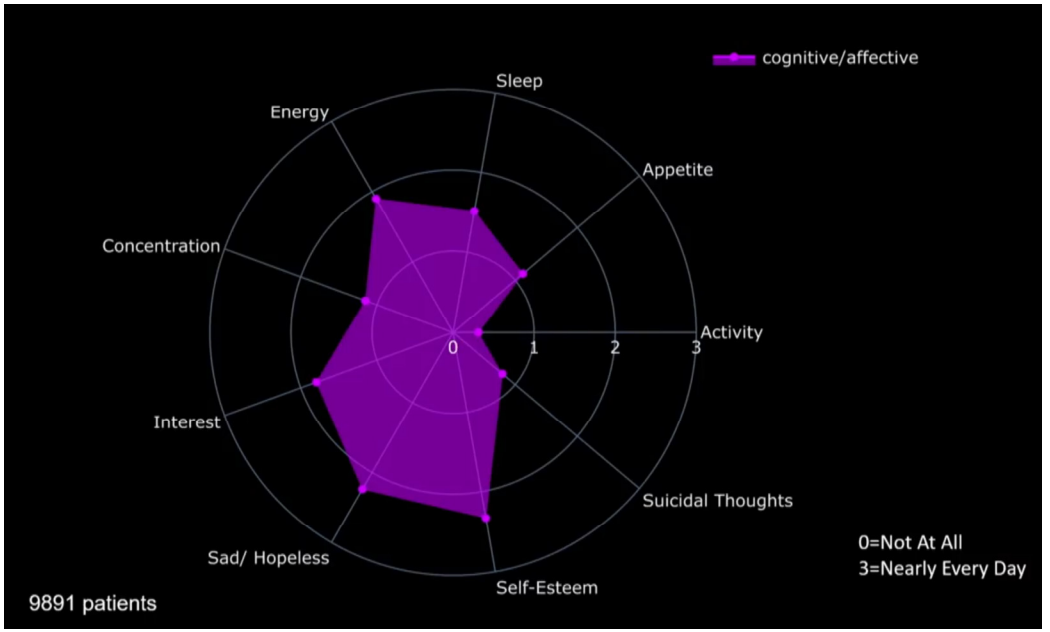
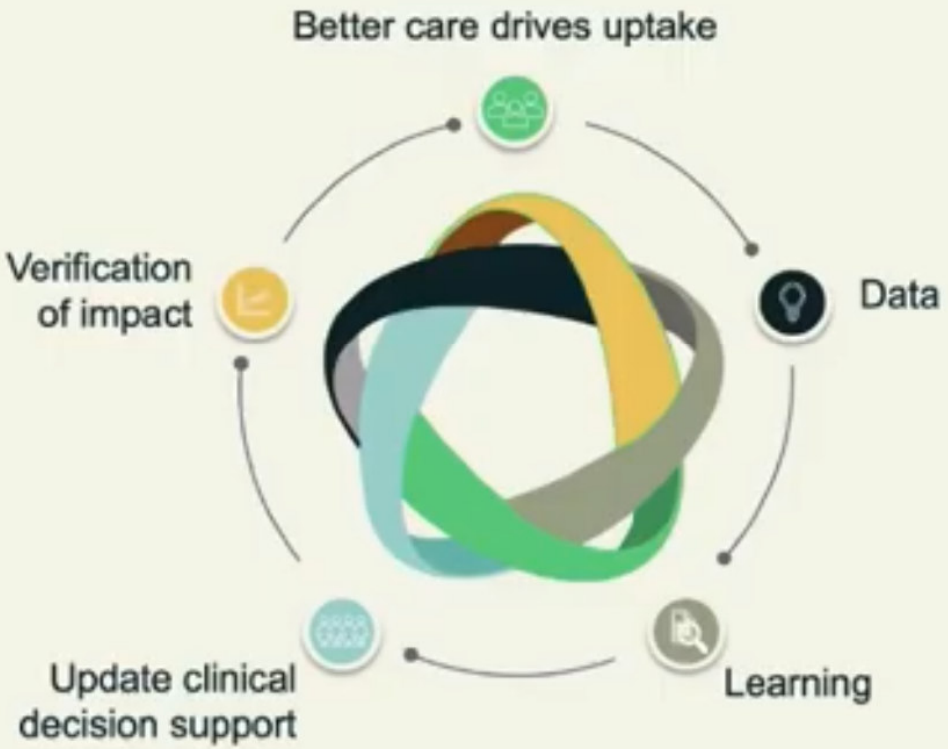
9891 patients


somatic
Sleep
Energy
Appetite
Concentration
Activity
0
1
2
3
Interest
Suicidal Thoughts
Sad/ Hopeless
Self-Esteem
0=Not At All
3=Nearly Every Day
9891 patients


cognitive/affective
Sleep
Energy
Appetite
Concentration
Activity
0
1
2
3
Interest
Suicidal Thoughts
Sad/ Hopeless
Self-Esteem
0=Not At All
3=Nearly Every Day
9891 patients

Data-enabled care models can improve outcomes in short cycles



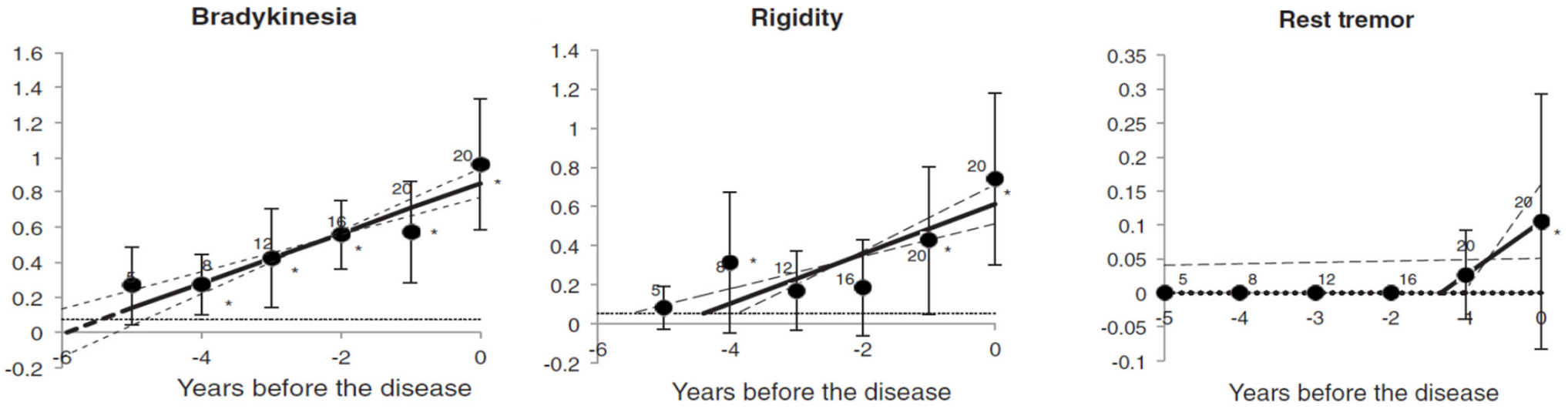
Clinical Recovery Rates 2013-2020 (IESO Benchmark Cohort Depressive Episode and Generalised Anxiety Disorder)

ieso digital health

eightbillionminds

MOVEMENT Analysis

Early diagnosis



(Postuma et al., 2012)

Finger Tapping

Hand Movements

Pronatio-Supination

Toe Tapping

Leg Agility

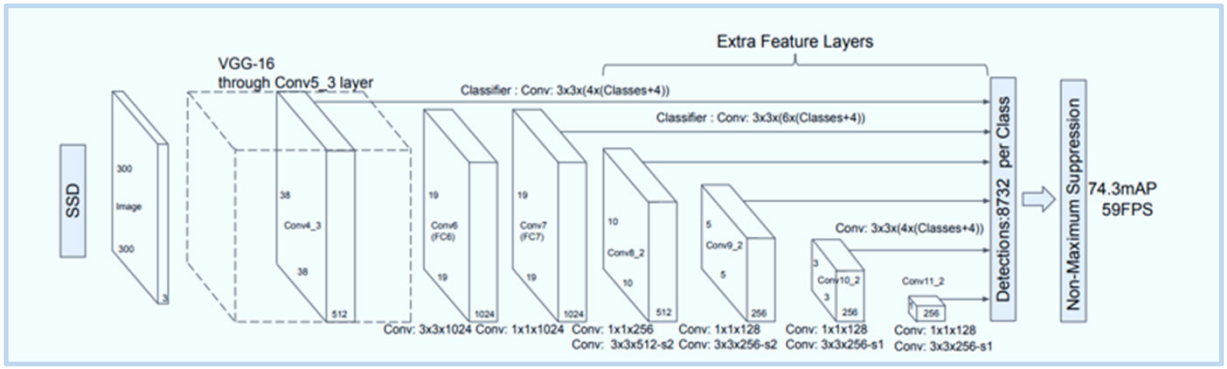
0: Normal:	No problem.
1: Slight:	Any of the following: a) the regular rhythm is broken with one or two interruptions or hesitations of the movement; b) slight slowing; c) the amplitude decrements near the end of the task.
2: Mild:	Any of the following: a) 3 to 5 interruptions during the movements; b) mild slowing; c) the amplitude decrements midway in the task.
3: Moderate:	Any of the following: a) more than 5 interruptions during the movement or at least one longer arrest (freeze) in ongoing movement; b) moderate slowing; c) the amplitude decrements starting after the 1st open-and-close sequence.
4: Severe:	Cannot or can only barely perform the task because of slowing, interruptions or decrements.

Quantitative Analysis

- Variability of Frequency
- Amplitude (m)
- Velocity (m/s)

VIDEO

Deep learning Landmarks detection



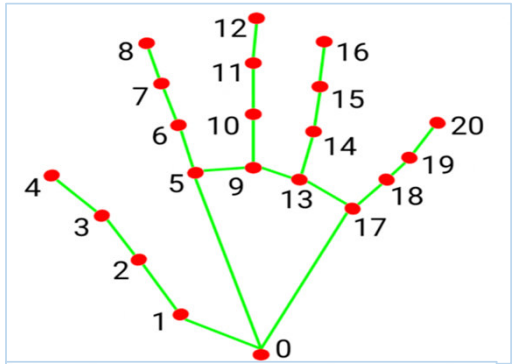
Camera-based

VIDEO

Deep learning Landmarks detection

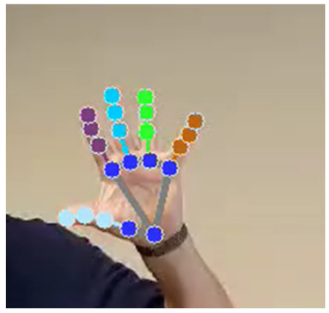
Camera-based

Hand Landmarks

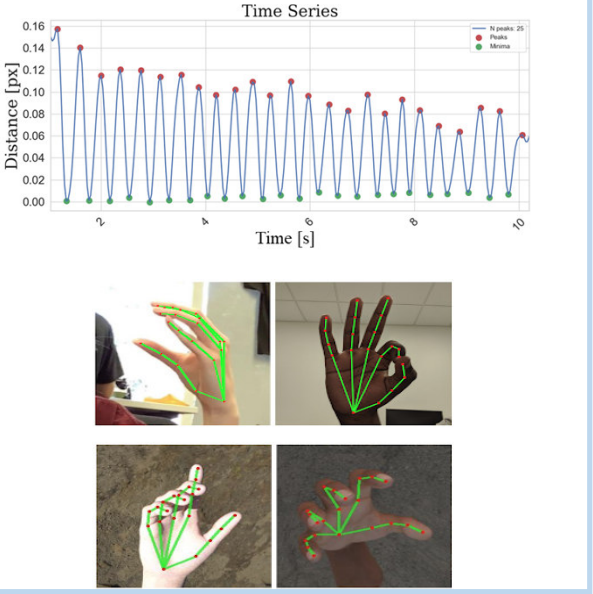


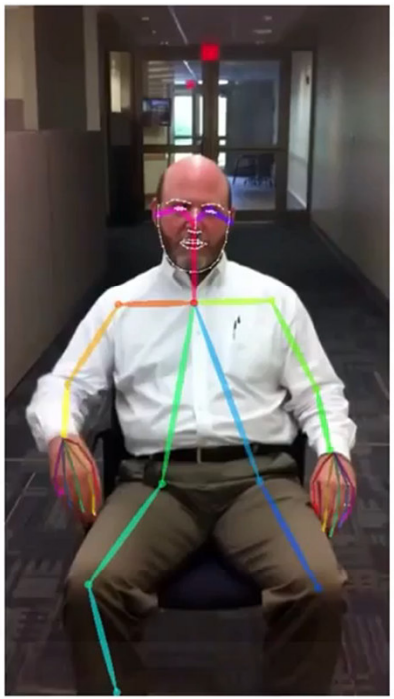
0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

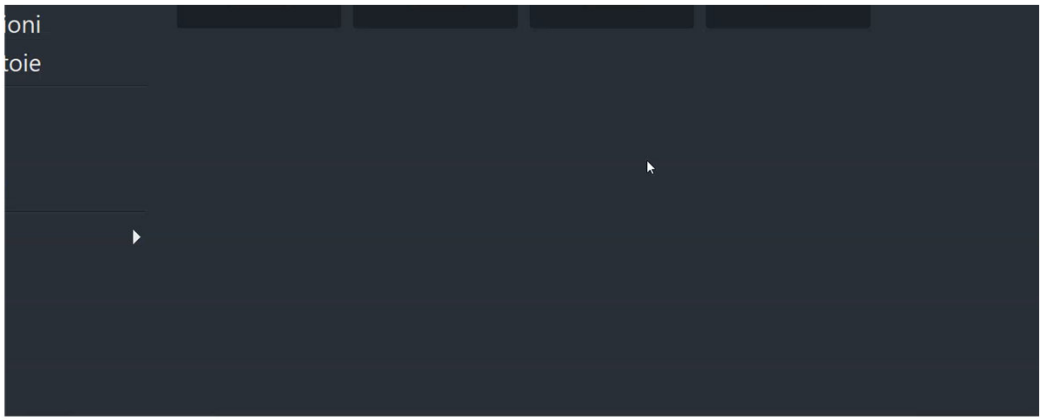
VIDEO with landmarks



Kinematic analysis and Pose detection







Camera-based

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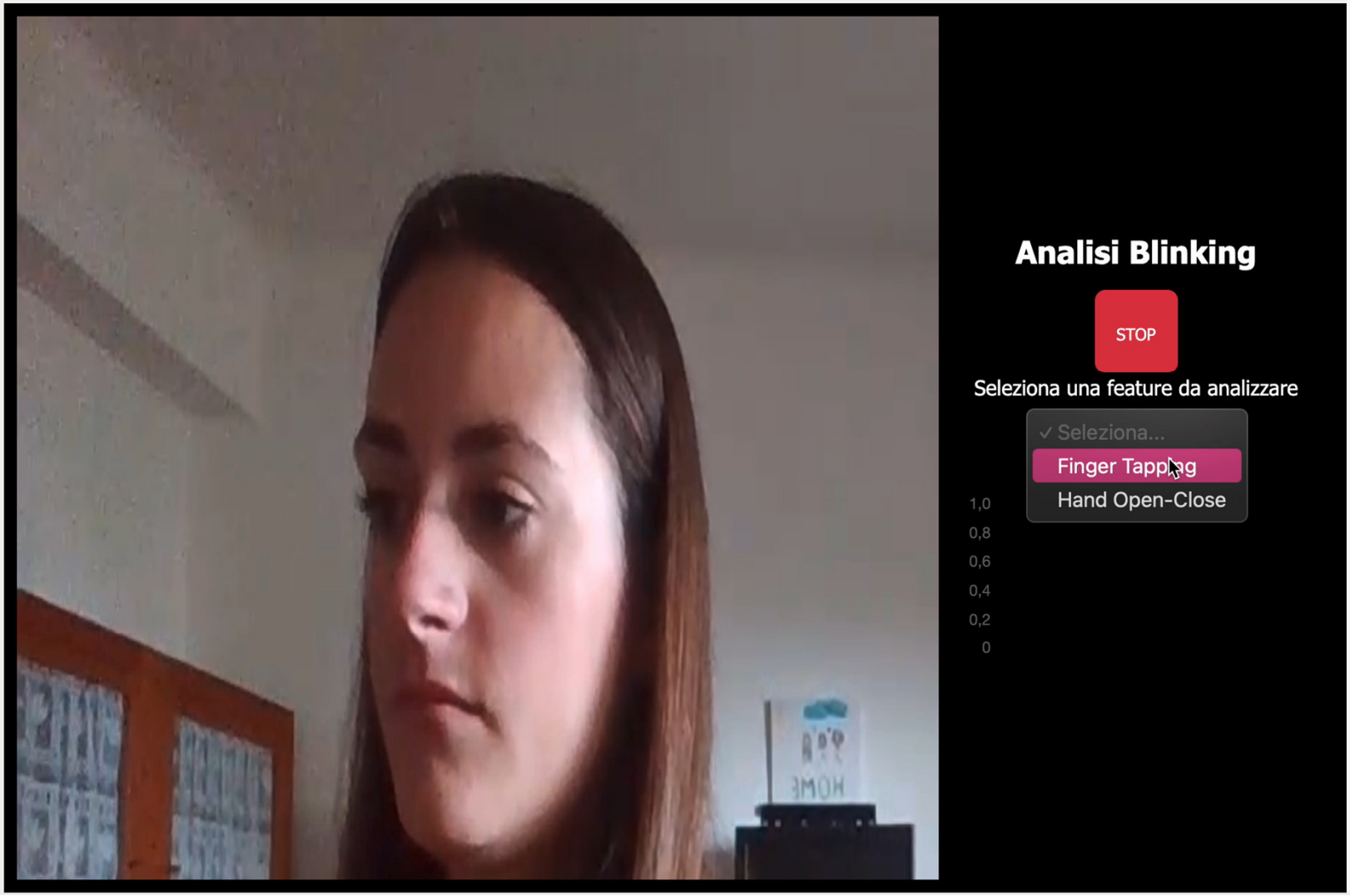
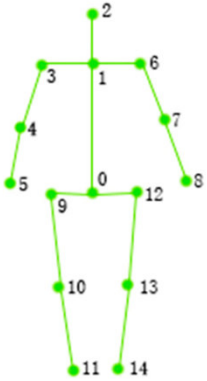
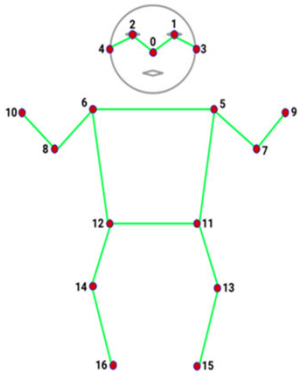

Abbandona
Video
Condividi
Microfono
Partecipanti
Chat
Altro
Analisi Blinking
STOP
Seleziona una feature da analizzare
✓ Seleziona...
Finger Tapping
Hand Open-Close
1,0
0,8
0,6
0,4
0,2
0
Movement Analysis
Patients Paziente
Models
Face Model
Pose Model
Hand Model
Selected Model: hand
Disable analysis
✕ Close

Full body analysis

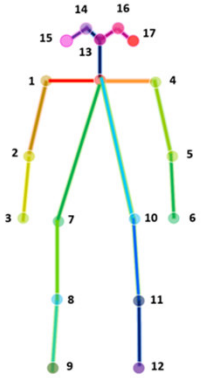
Camera-based



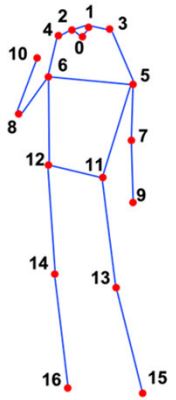
Openpose
15 pt



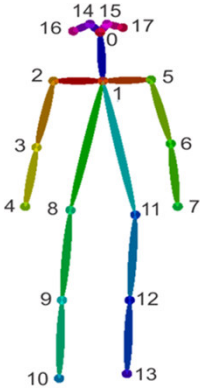
COCO / MoveNet / PoseNet
/ Yolo / Efficent-pose
17 pt



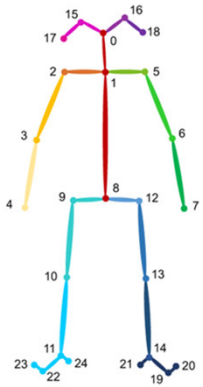
Alphapose
17 pt



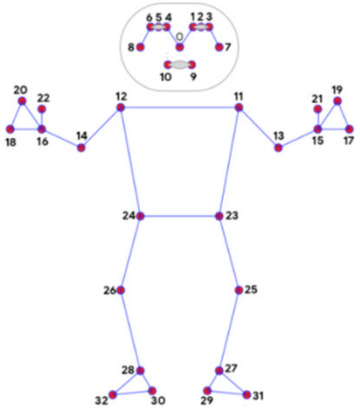
HRNET
17 pt



Openpose
18 pt



Openpose
25 pt



Mediapipe Balzepose
33 pt

Densepose
3D

di Biase, L., et al. (2025). *Sensors*.
https://doi.org/10.3390/s25206373

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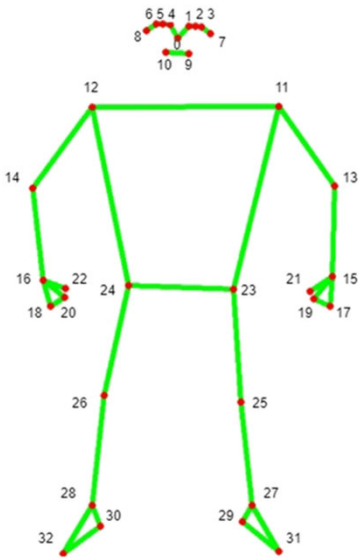
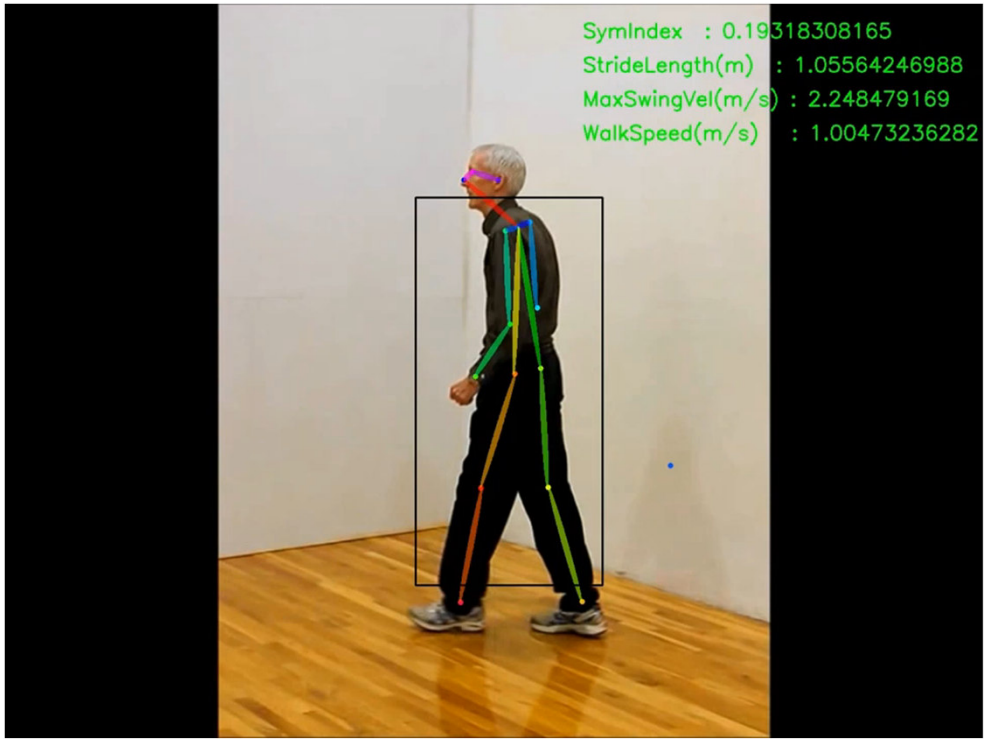
lazzaro.dibiase@braininnovations.eu
Brain Innovations

Camera-based

Full body analysis



0. nose
1. left eye inner
2. left eye
3. left eye outer
4. right eye inner
5. right eye
6. right eye outer
7. left ear
8. right ear
9. mouth left
10. mouth right
11. left shoulder
12. right shoulder
13. left elbow
14. right elbow
15. left wrist
16. right wrist
17. left pinky
18. right pinky
19. left index
20. right index
21. left thumb
22. right thumb
23. left hip
24. right hip
25. left knee
26. right knee
27. left ankle
28. right ankle
29. left heel
30. right heel
31. left foot index
32. right foot index



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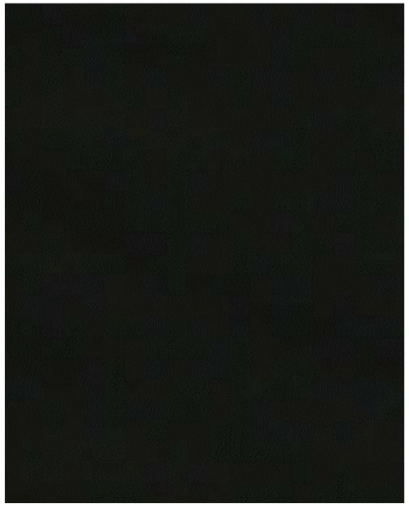
Bradykinesia

Slowness of initiation of volountary movements

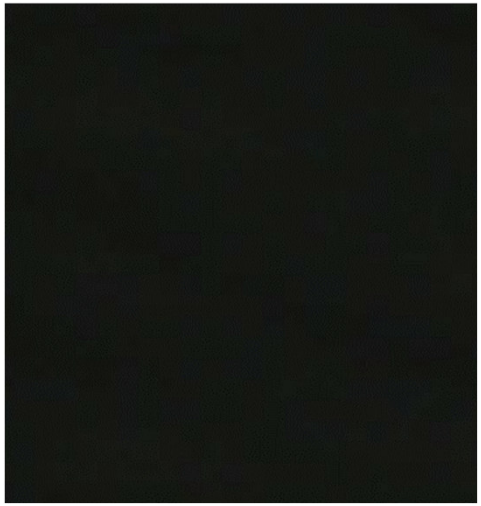
with **progressive reduction** in **speed** and **amplitude** of repetitive action

0:	Normal:	No problems.
1:	Slight:	Any of the following: a) the regular rhythm is broken with one or two interruptions or hesitations of the tapping movement; b) slight slowing; c) the amplitude decrements near the end of the 10 taps.
2:	Mild:	Any of the following: a) 3 to 5 interruptions during tapping; b) mild slowing; c) the amplitude decrements midway in the 10-tap sequence.
3:	Moderate:	Any of the following: a) more than 5 interruptions during tapping or at least one longer arrest (freeze) in ongoing movement; b) moderate slowing; c) the amplitude decrements starting after the 1st tap.
4:	Severe:	Cannot or can only barely perform the task because of slowing, interruptions or decrements.

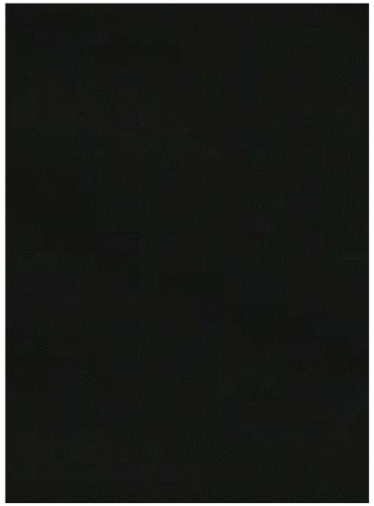
Normal



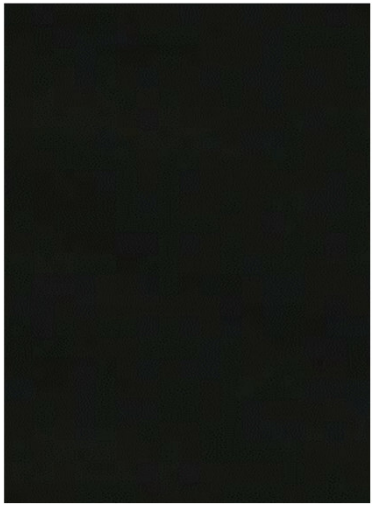
Slight Bradykinesia



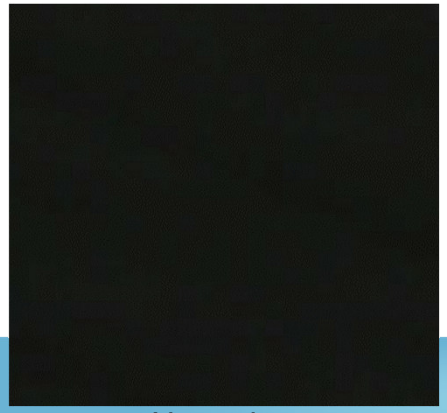
Mild Bradykinesia



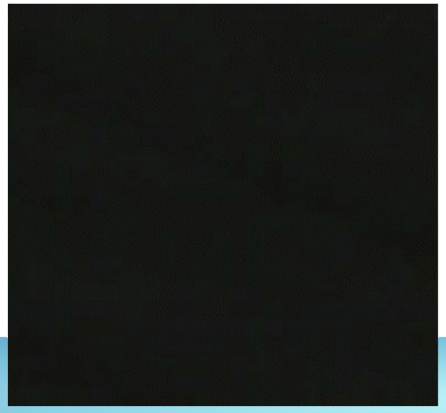
Moderate Bradykinesia



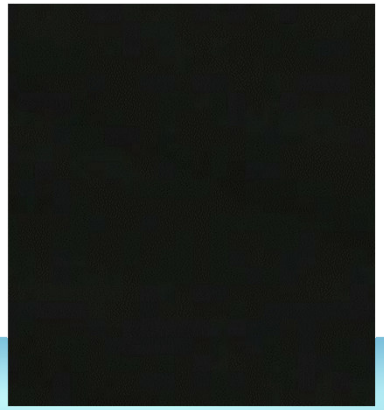
Severe Bradykinesia



Normal

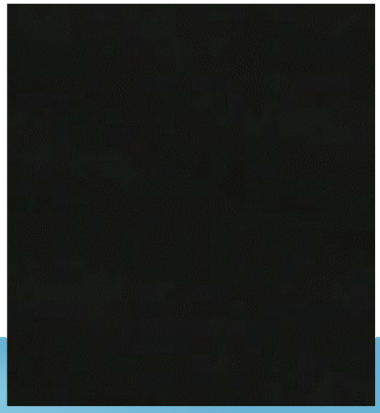


Slight Bradykinesia



Mild Bradykinesia

Moderate Bradykinesia

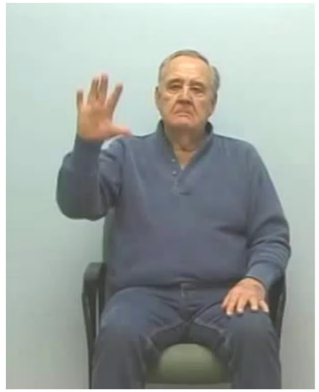


Severe Bradykinesia

Bradykinesia

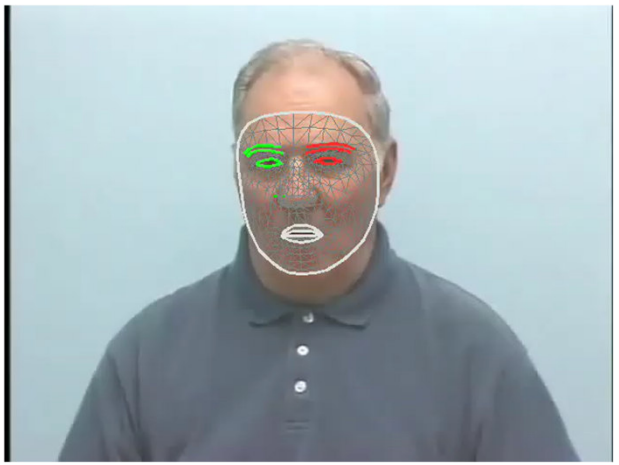
- **Slowness** of initiation of volountary movements
- with **progressive reduction** in **speed** and **amplitude** of repetitive action

0: Normal:	No problems.
1: Slight:	Any of the following: a) the regular rhythm is broken with one or two interruptions or hesitations of the tapping movement; b) slight slowing; c) the amplitude decrements near the end of the 10 taps.
2: Mild:	Any of the following: a) 3 to 5 interruptions during tapping; b) mild slowing; c) the amplitude decrements midway in the 10-tap sequence.
3: Moderate:	Any of the following: a) more than 5 interruptions during tapping or at least one longer arrest (freeze) in ongoing movement; b) moderate slowing; c) the amplitude decrements starting after the 1st tap.
4: Severe:	Cannot or can only barely perform the task because of slowing, interruptions or decrements.

Normal	Slight Bradykinesia	Mild Bradykinesia	Moderate Bradykinesia	Severe Bradykinesia
				
				
a: 0,15 px **v: 0,91 px/s**	**a: 0,07 px** **v: 0,44 px/s**	**a: 0,05 px** **v: 0,14 px/s**	**a: 0,01 px** **v: 0,13 px/s**	**a: 0,02 px** **v: 0,08 px/s**

Rest Tremor

f: 6,1 Hz

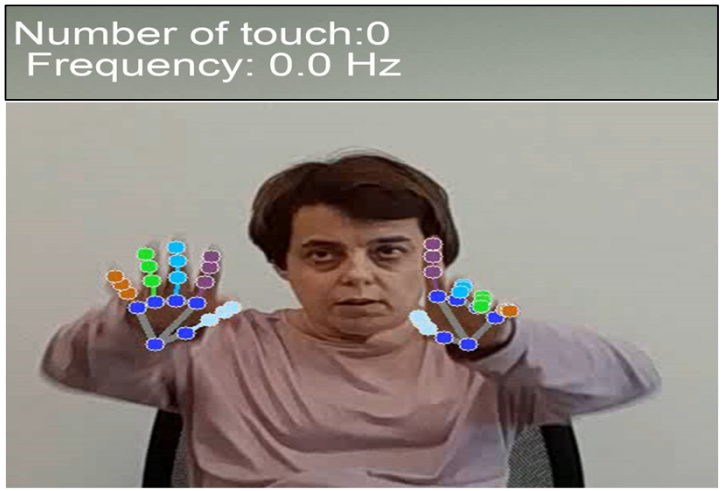


f: 2,4 Hz

VIDEO ANALYSIS

FINGER TAPPING

ON



OFF

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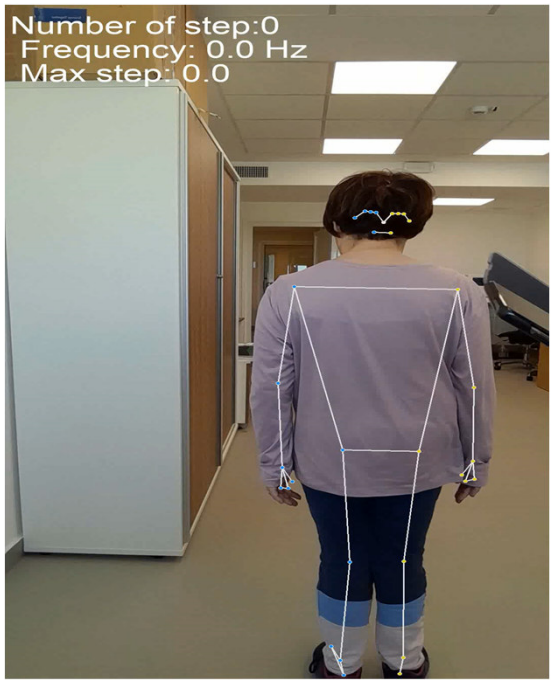
VIDEO ANALYSIS

GAIT

ON
mild dyskinesias



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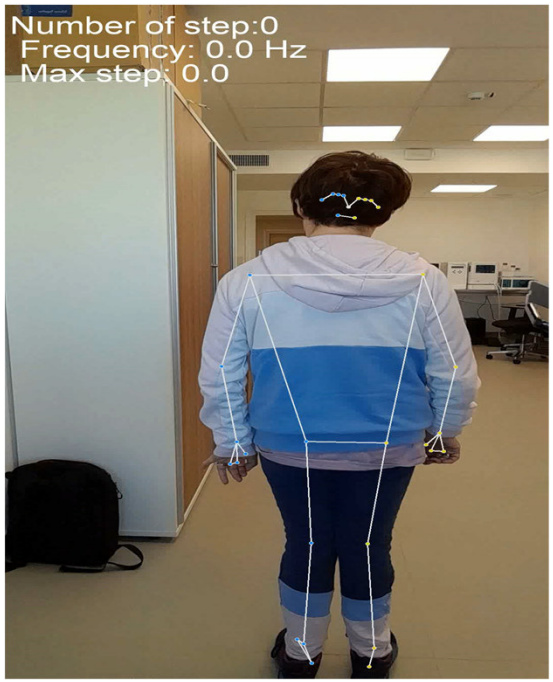


Caso clinico: caratteristiche generali del paziente

Overview dei paziente

- Età al momento dell'impianto: 68 anni
- Sesso: M
- Situazione familiare: caregiver (moglie), figlia
- Status lavorativo: pensionato

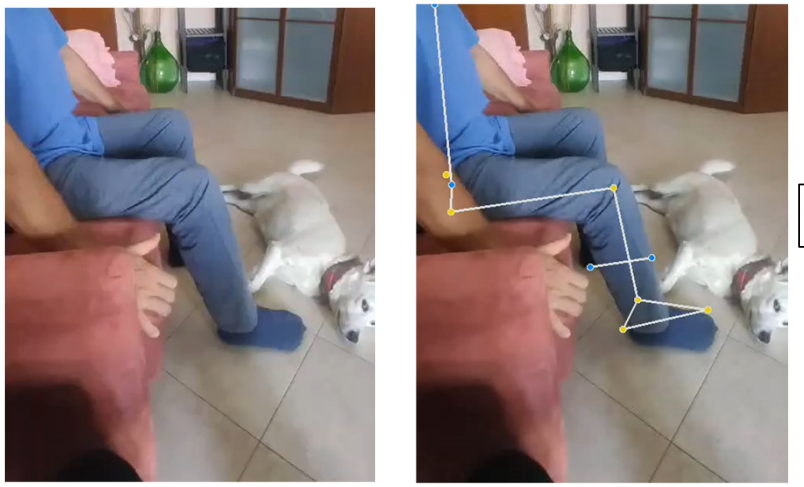
Caratteristiche cliniche

- Età alla diagnosi: 59 anni
- Durata di malattia: 9 anni
- Anno di comparsa delle fluttuazioni motorie: 65 anni
- Off: 3-4 ore, frequenti cadute, Discinesie 2-3 ore
- Presenza di sintomi non motori: iposmia, stipsi, RBD, sindrome ansioso-depressiva, difficoltà prassico costruttiva con profilo cognitivo globale conservato, allucinazioni e shopping compulsivo
- Sonno: insonnia intermedia
- Presenza di acinesia al risveglio e notturna
- Comorbidità: deficit ipofisario (apoplessia ipofisaria)

OFF

f 0,54 Hz

OFF



f 0,44 Hz

Caso clinico: caratteristiche generali del paziente

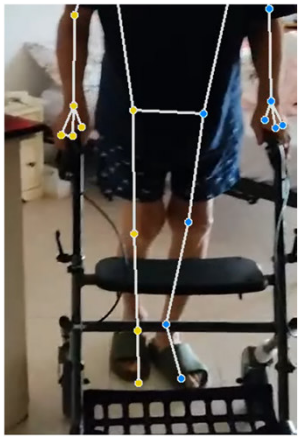
Overview dei paziente

- Età al momento dell'impianto: 68 anni
- Sesso: M
- Situazione familiare: caregiver (moglie), figlia
- Status lavorativo: pensionato

Caratteristiche cliniche

- Età alla diagnosi: 59 anni
- Durata di malattia: 9 anni
- Anno di comparsa delle fluttuazioni motorie: 65 anni
- Off: 3-4 ore, frequenti cadute, Discinesie 2-3 ore
- Presenza di sintomi non motori: iposmia, stipsi, RBD, sindrome ansioso-depressiva, difficoltà prassico costruttiva con profilo cognitivo globale conservato, allucinazioni e shopping compulsivo
- Sonno: insonnia intermedia
- Presenza di acinesia al risveglio e notturna
- Comorbidità: deficit ipofisario (apoplessia ipofisaria)

OFF



vel 0,64 px/s

ON

vel 1,69 px/s

Caso clinico: caratteristiche generali del paziente

Overview dei paziente

- Età al momento dell'impianto: 68 anni
- Sesso: M
- Situazione familiare: caregiver (moglie), figlia
- Status lavorativo: pensionato

Caratteristiche cliniche

- Età alla diagnosi: 59 anni
- Durata di malattia: 9 anni
- Anno di comparsa delle fluttuazioni motorie: 65 anni
- Off: 3-4 ore, frequenti cadute, Discinesie 2-3 ore
- Presenza di sintomi non motori: iposmia, stipsi, RBD, sindrome ansioso-depressiva, difficoltà prassico costruttiva con profilo cognitivo globale conservato, allucinazioni e shopping compulsivo
- Sonno: insonnia intermedia
- Presenza di acinesia al risveglio e notturna
- Comorbidità: deficit ipofisario (apoplessia ipofisaria)

OFF

f 0,1 Hz

ON

f 0,8 Hz

Caso Clinico: implementazione della terapia

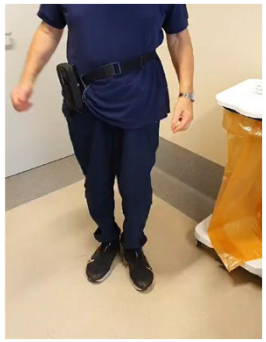
Descrizione dell'implementazione

- **Modalità di implementazione:** ambulatorio
- **Durata dell'implementazione:** 1h (due visite di 30 min separate da 3 h)
- **LEDD pre impianto** 825 mg
- Terapia infusionale sottocutanea con FOSCARBIDOPA/FOSLEVODOPA 120/2400 mg:
  - **Dose base 0,25 ml/h**
  - **Dose alta 0,27 ml/h**
  - **Dose notturna 0,22 ml/h**
  - **Dose Extra 0,20 ml**
  - **Dose di carico 0,6 ml**
  - **Ago 9 mm**

LE_{PO} (valore di LE derivante da tutti i medicinali orali contenenti levodopa assunti in un periodo di veglia di 16 ore), (mg)	Velocità di infusione oraria iniziale raccomandata per Duodopa soluzione per infusione sottocutanea (ml/h)* somministrato nel corso delle 24 ore
<400	0,15
400-499	0,15-0,17
500-599	0,17-0,20
600-699	0,20-0,24
700-799	0,24-0,27
800-899	0,27-0,30
900-999	0,30-0,34
1000-1099	0,34-0,37

- **Terapie associate:** Safinamide 100 mg
- **Formazione al paziente/caregiver:** in sede ed a casa
- **Efficacia clinica:** buona
- **Off: 1 ora (trattato con dose extra), regressione delle cadute, Discinesie: lievi; risoluzione di acinesia notturna e al risveglio**
- **Soddisfazione del paziente e del caregiver:** ottima

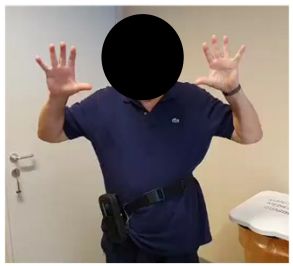
ON

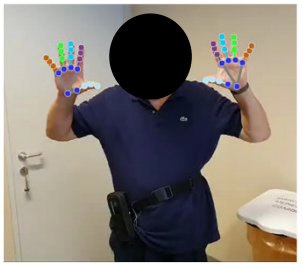


f 1 Hz

$$\frac{\text{ON}}{\text{OFF}} = \text{x } 2$$

ON

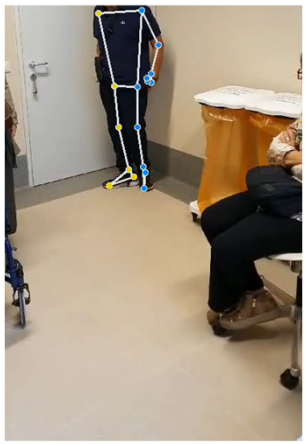




f 0,85 Hz

$$\frac{\text{ON}}{\text{OFF}} = \text{x } 8,5$$

ON



vel 1,5 px/s

$$\frac{\text{ON}}{\text{OFF}} = \text{x } 2,3$$

Parkinson’s disease telemanagement

OFF

vel 0,64 px/s

Ldopa Orale
825 mg (6 dosi ogni 3 h)

ON

vel 1,5 px/s

SC FosLDopa
Dose base 0,25 ml/h 16h/die
Dose notturna 0,22 ml/h 8h/die
Dose alta 0,27 ml/h
Dose Extra 0,20 ml

ON

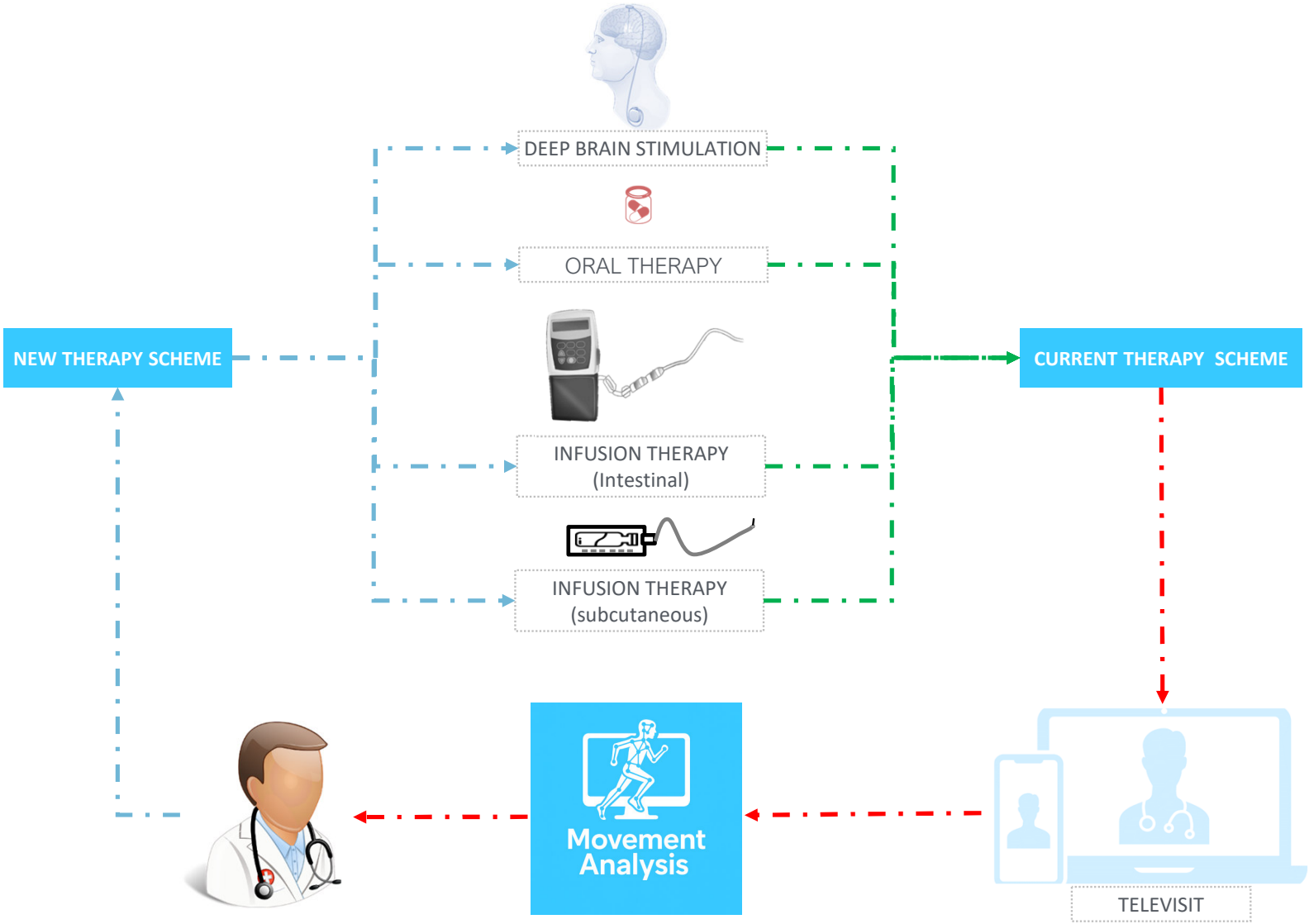
vel 1,5 px/s

SC FosLDopa
Dose alta 0,27 ml/h 16h/die
Dose notturna 0,22 ml/h 8h/die
Dose base 0,25 ml/h
Dose Extra 0,20 ml

ON

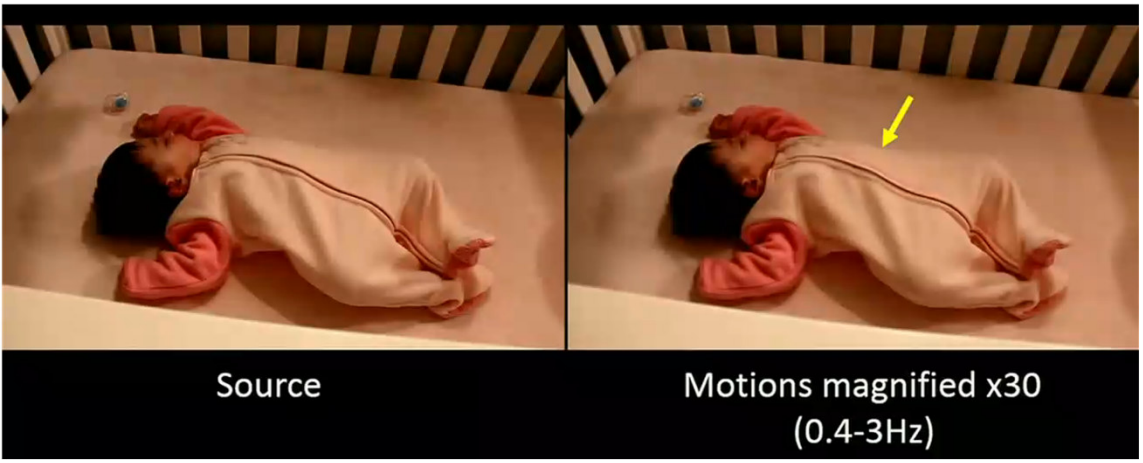
vel 1,7 px/s

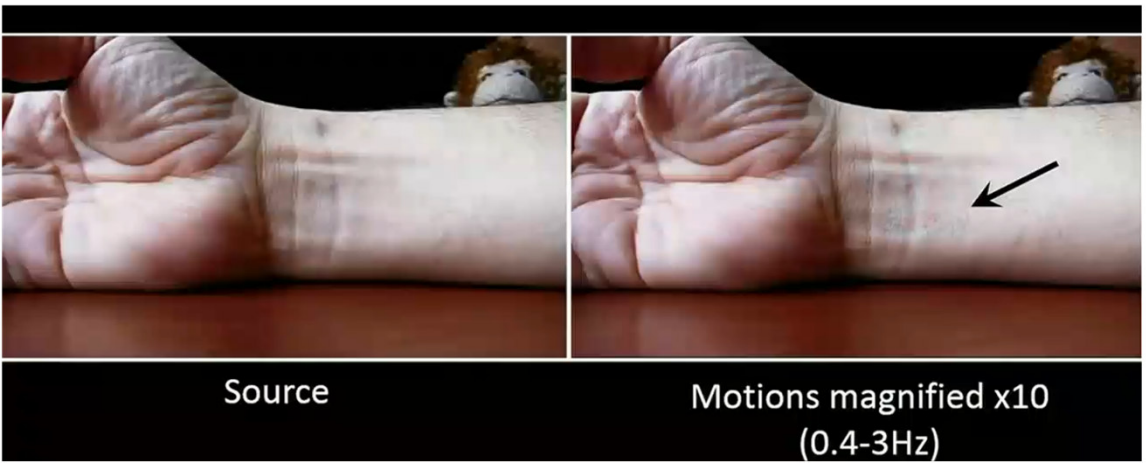
SC FosLDopa
Dose alta 0,30 ml/h 16h/die
Dose notturna 0,25 ml/h 8h/die
Dose base 0,28 ml/h
Dose Extra 0,3 ml

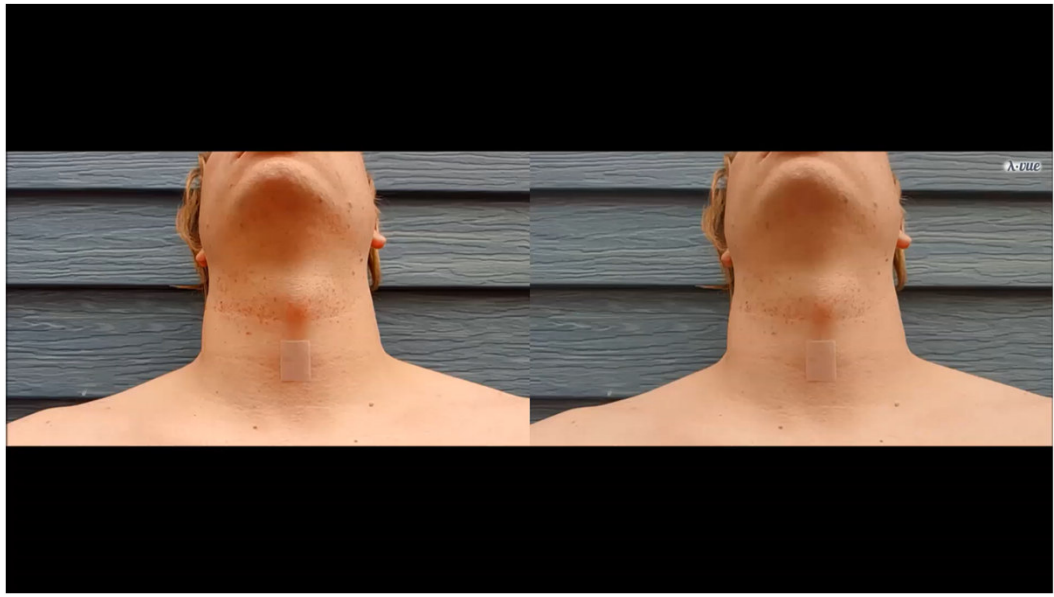

DEEP BRAIN STIMULATION
ORAL THERAPY
NEW THERAPY SCHEME
CURRENT THERAPY SCHEME
INFUSION THERAPY
(Intestinal)
INFUSION THERAPY
(subcutaneous)
Movement
Analysis
TELEVISIT

VIDEO Magnification

Video magnification



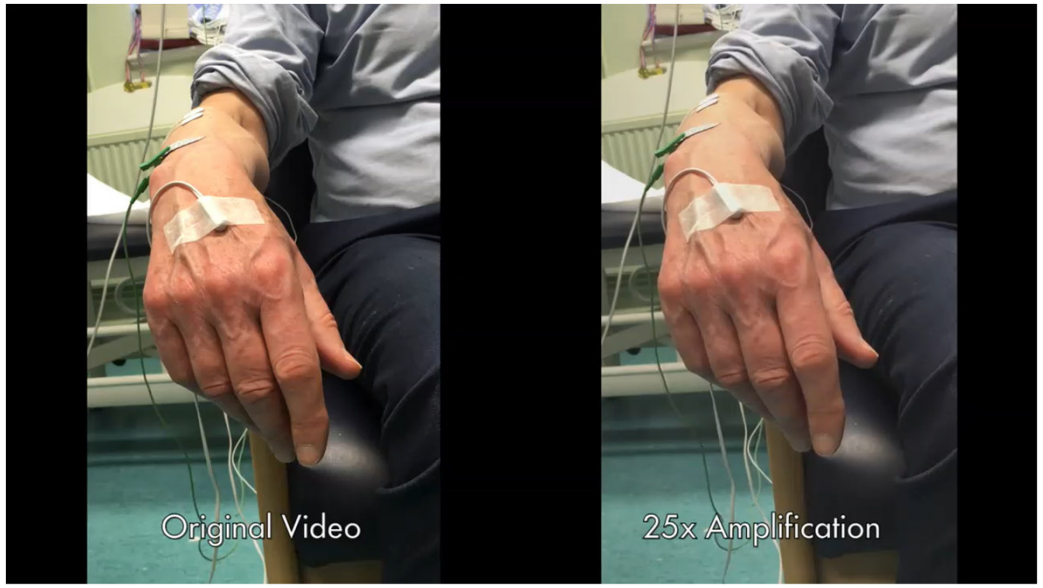




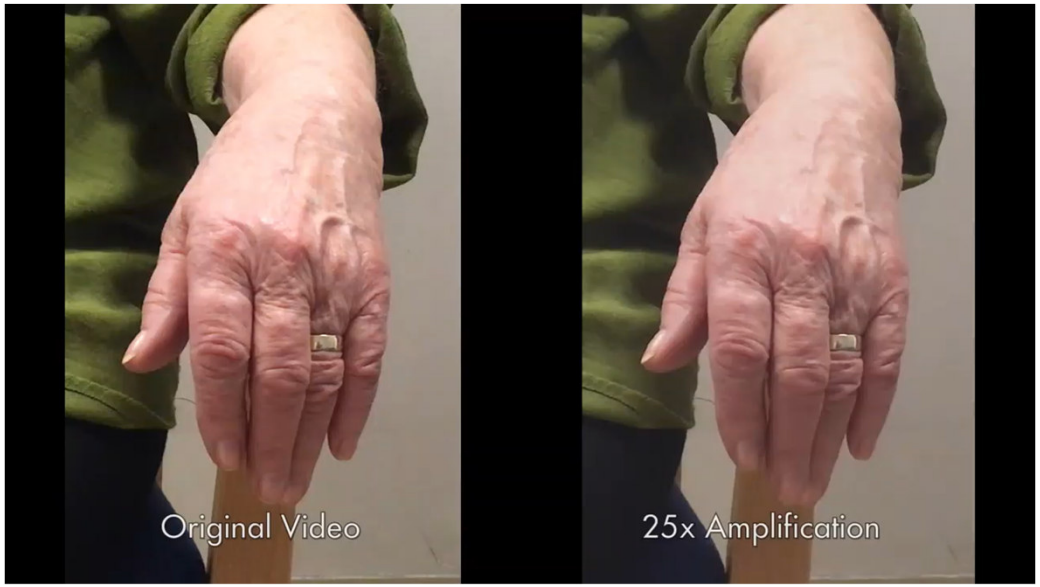
Lauridsen H, eta l. Extracting physiological information in experimental biology via Eulerian video magnification. BMC Biol. 2019 Dec 12;17(1):103. doi: 10.1186/s12915-019-0716-7. PMID: 31831016; PMCID: PMC6907275.

Video magnification

Parkinson's disease



Healthy subject



Williams S, et al. Seeing the unseen: Could Eulerian video magnification aid clinician detection of subclinical Parkinson's tremor? J Clin Neurosci. 2020 Nov;81:101-104. doi: 10.1016/j.jocn.2020.09.046. Epub 2020 Oct 2. PMID: 33222895.

Rigidity

0: Normal: No rigidity.

1: Slight: Rigidity only detected with activation maneuver.

2: Mild: Rigidity detected without the activation maneuver, but full range of motion is easily achieved.

3: Moderate: Rigidity detected without the activation maneuver; full range of motion is achieved with effort.

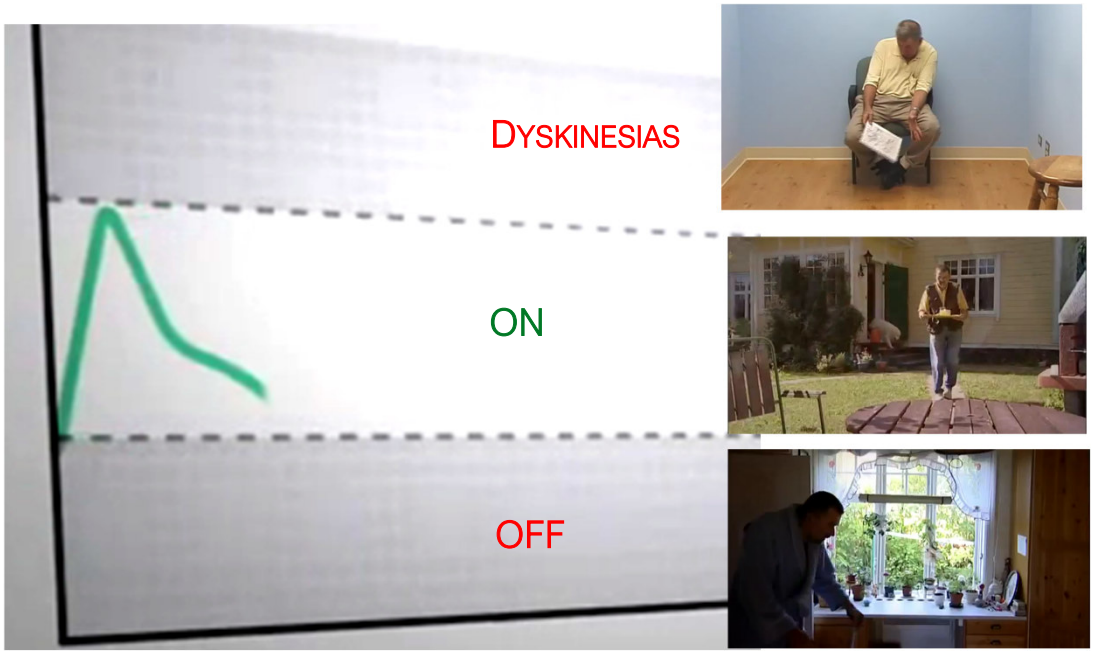
4: Severe: Rigidity detected without the activation maneuver and full range of motion not achieved.

Rigidity

Slow motion 0.5x

Motor Fluctuations

Costant fluctuation around ideal motor status



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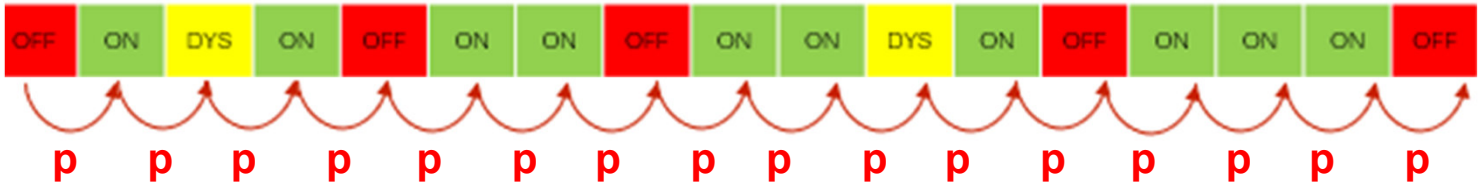
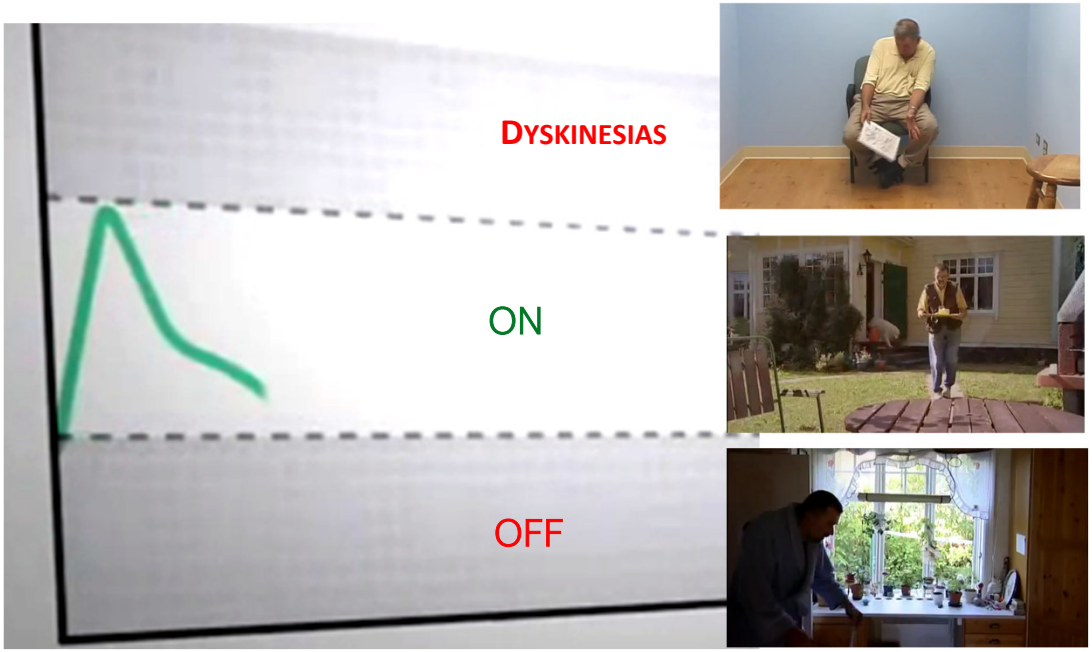
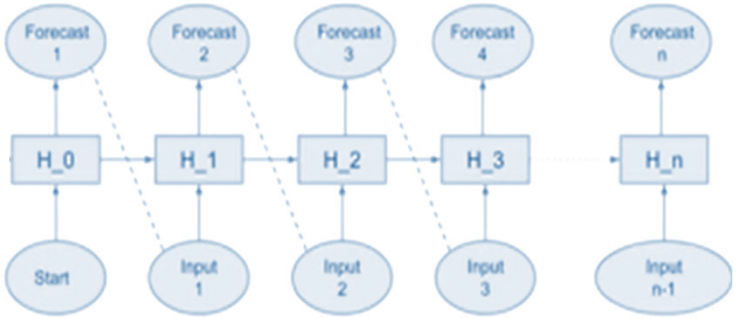
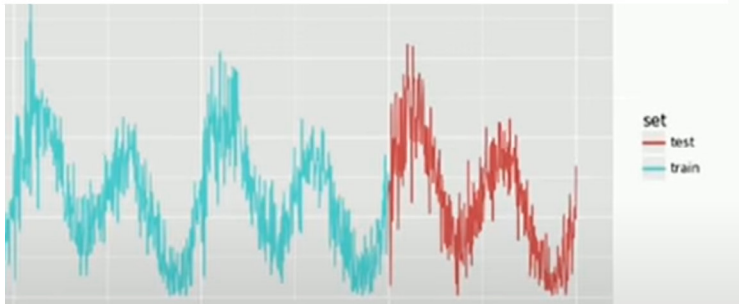
Therapy management









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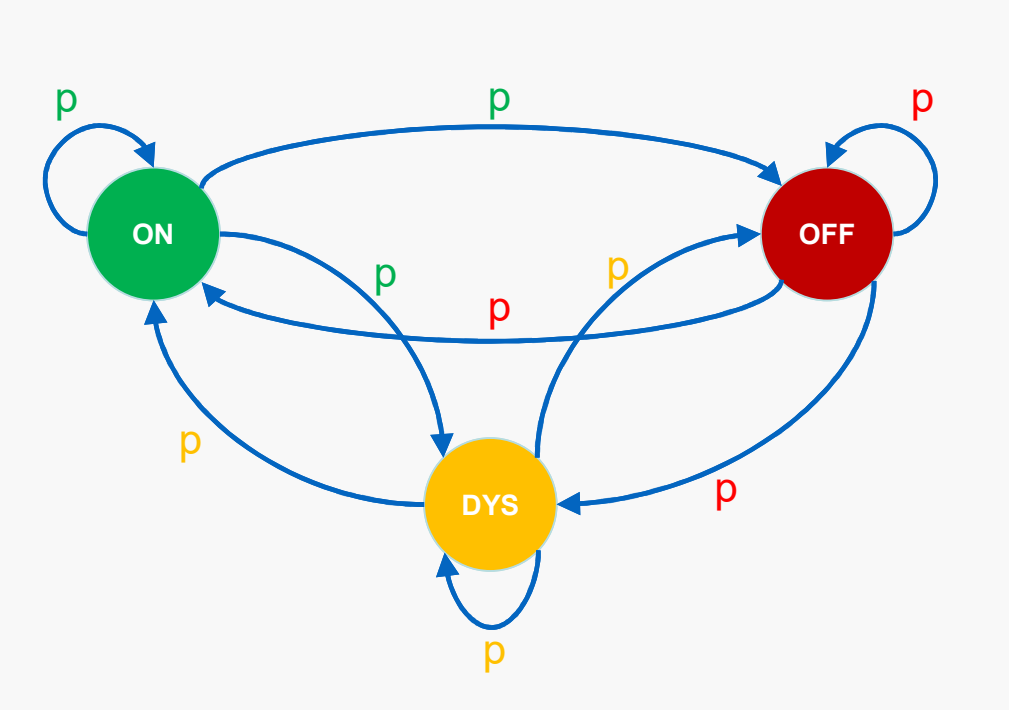
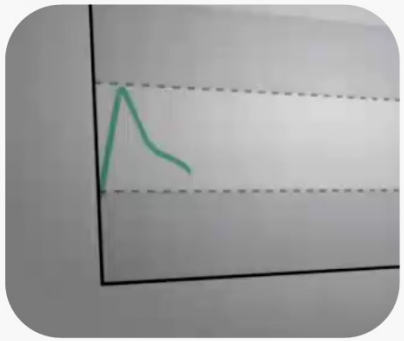
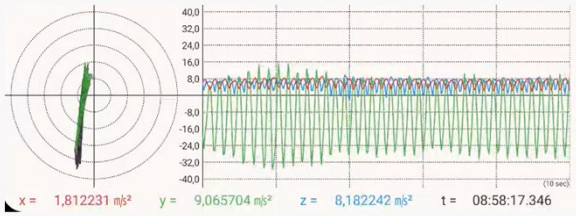


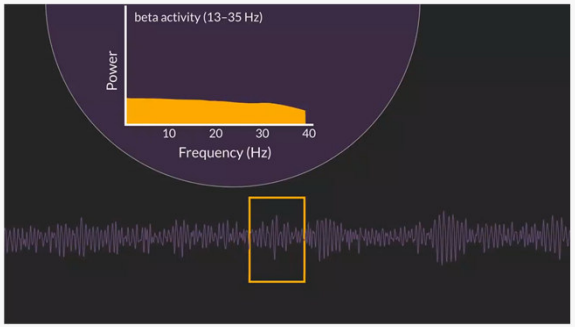
BIOCHEMICAL MONITORING



MOVEMENT MONITORING



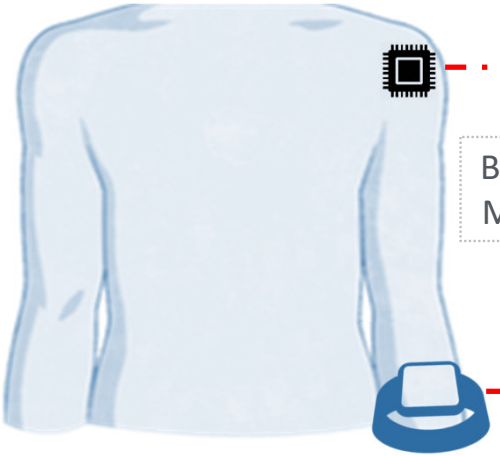
BRAIN ACTIVITY MONITORING



LFP MONITORING

DEEP BRAIN STIMULATION

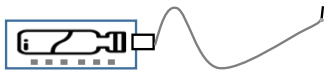
ORAL THERAPY



BIOCHEMICAL MONITORING

KINEMATIC MONITORING

INFUSION THERAPY (Intestinal)



INFUSION THERAPY (subcutaneous)

NEW THERAPY SCHEME

CURRENT THERAPY SCHEME

SENSING SYSTEM

ADAPTIVE CLOSED-LOOP
motor function stabilization algorithm

di Biase, Lazzaro. (2021). Adaptive closed-loop therapy system for Parkinson's disease. https://doi.org/10.5281/zenodo.4767082

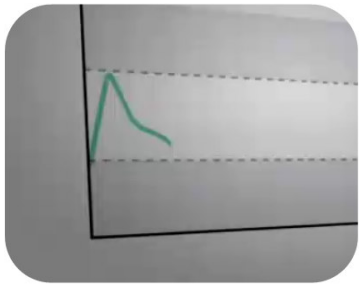
Therapy management solutions

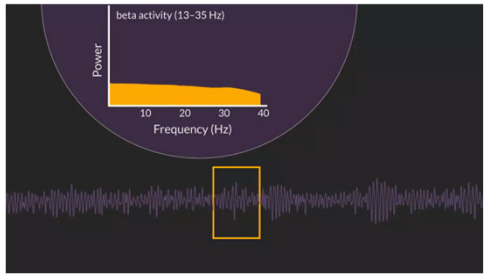
BIOCHEMICAL MONITORING

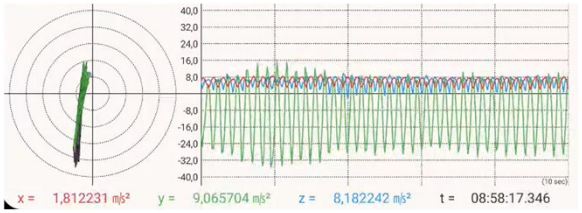
BRAIN ACTIVITY MONITORING

MOVEMENT MONITORING

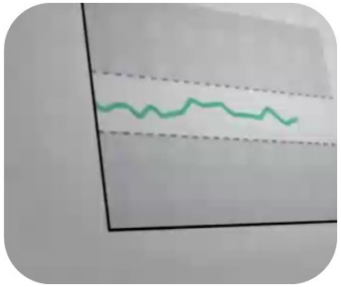
BEFORE

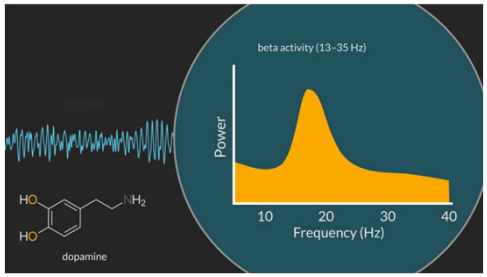


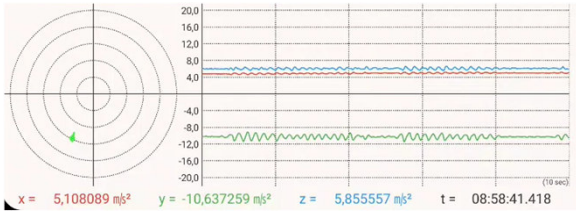




AFTER







di Biase L, et al. Adaptive, personalized closed-loop therapy for Parkinson's disease: biochemical, neurophysiological, and wearable sensing systems. Expert Rev Neurother. 2021 Dec;21(12):1371-1388. doi: 10.1080/14737175.2021.2000392. Epub 2021 Nov 17.

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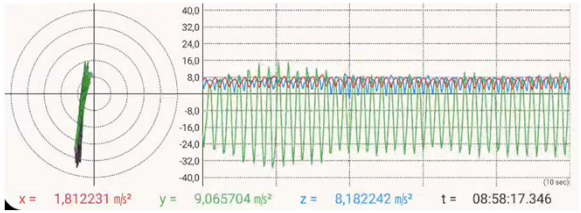
Movement monitoring



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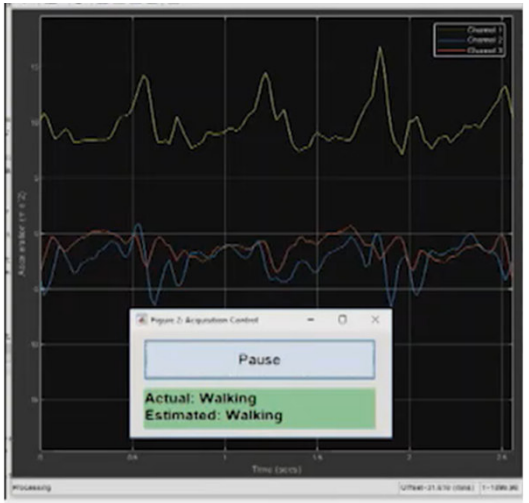
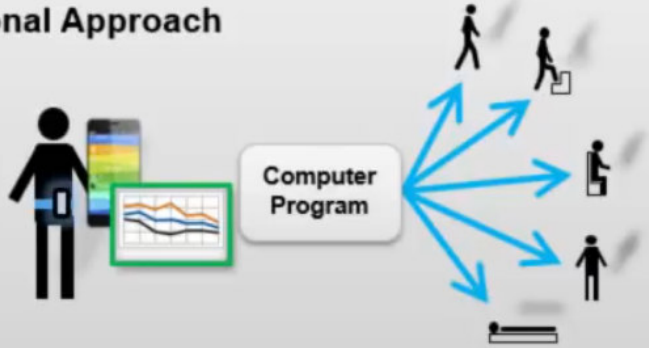


Traditional Approach



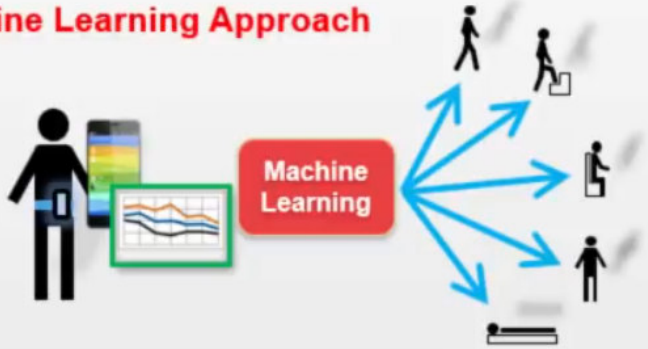
Hand Written Program

If X_acc > 0.5
then "SITTING"
If Y_acc < 4 and Z_acc > 5
then "STANDING"
…

Formula or Equation

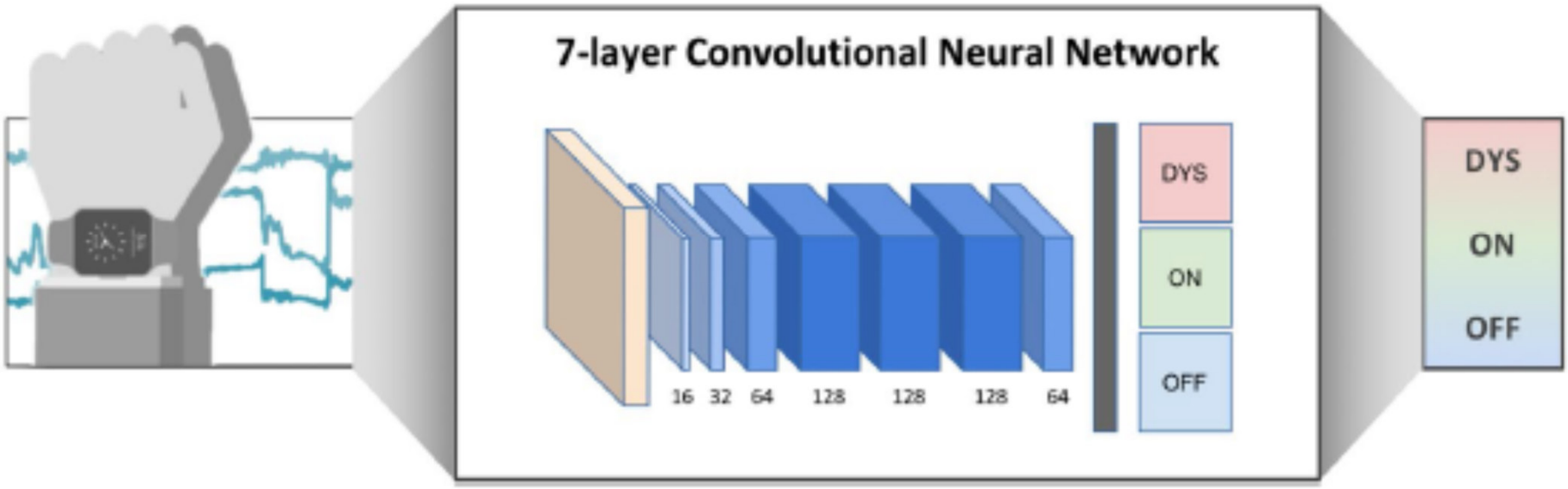
$$Y_{activity} = \beta_1 X_{acc} + \beta_2 Y_{acc} + \beta_3 Z_{acc} + \dots$$

Machine Learning Approach

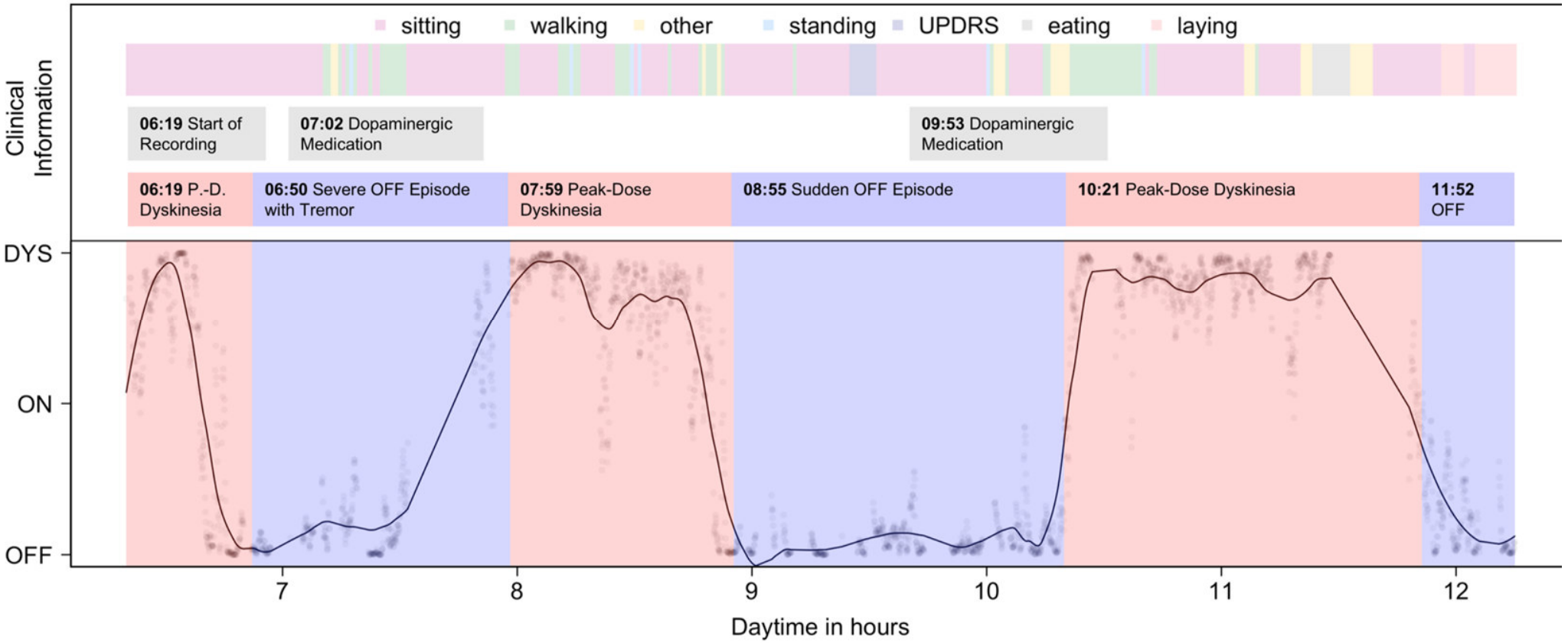


$model$: Inputs → Outputs

$$model = <^{Machine\ Learning\ Algorithm}>(sensor\_data, activity)$$



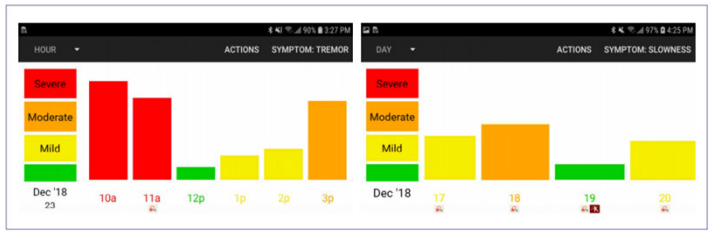
Pfister - High-Resolution Motor State Detection in Parkinson's Disease Using Convolutional Neural Networks



Pfister - High-Resolution Motor State Detection in Parkinson's Disease Using Convolutional Neural Networks

KinesiaU™
MOTOR ASSESSMENT SYSTEM

Objective Motor Assessment Using A Smartwatch



GREAT LAKES NEUROTECHNOLOGIES
Kinesia™

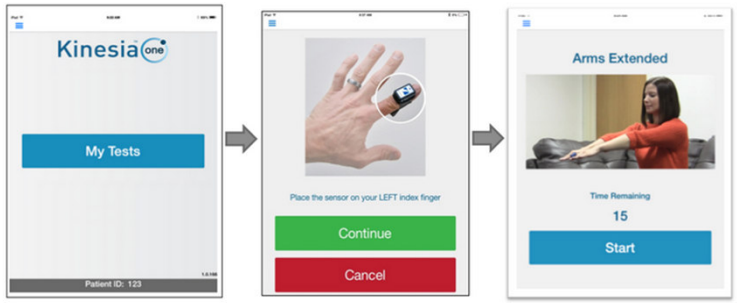
DEVELOPMENT STAGE

CERTIFICATIONS

CE ISO 13485 FDA

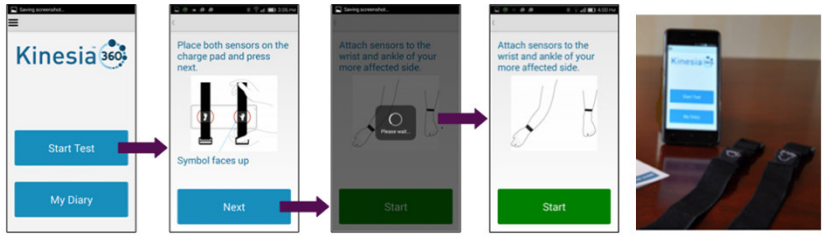
Kinesia™ one

Objective, Task-Based Motor Assessments Using Sensor & App



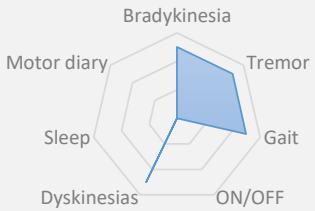
Kinesia™ 360

Objective, Continuous Symptom Monitoring Using Wearables & App

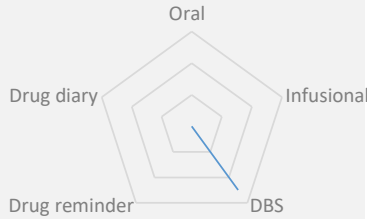


DIAGNOSIS

SYMPTOMS MONITORING



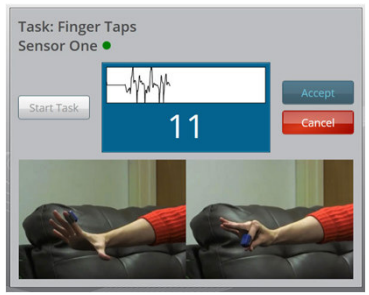
THERAPY MANAGEMENT

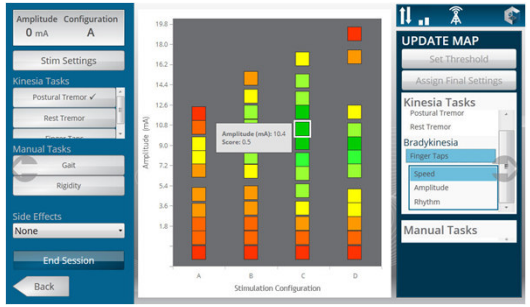


Kinesia ProView™

Visualize Symptom Response To Deep Brain Stimulation

The Kinesia ProView kit includes a carrying case, tablet PC with integrated broadband, and charge pad with wireless sensors to capture motor symptom severity.





Task-Based Motor Assessments

Kinesia one

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
7:01 AM	4.0	3.5	2.5	2.4	2.2	0.0
7:02 AM	SINEMET (100mg)					
7:32 AM	3.4	3.3	1.7	1.4	1.0	0.0
8:01 AM	3.0	3.0	1.8	1.8	1.2	0.0
8:34 AM	2.9	2.8	1.3	1.2	1.0	0.0
9:00 AM	2.8	2.4	1.2	1.1	1.2	0.0
9:23 AM	2.8	2.6	1.0	1.0	1.0	0.0
10:00 AM	2.6	2.8	1.0	1.0	1.0	0.0
10:33 AM	3.2	3.3	1.5	1.9	1.5	0.0
11:01 AM	3.5	3.5	2.3	2.2	2.0	0.0
11:30 AM	3.7	3.8	2.0	2.0	1.8	0.0
12:00 PM	SINEMET (100mg)					
12:01 PM	3.3	3.8	2.6	2.7	2.0	0.0
12:32 PM	3.2	3.4	1.8	1.9	2.0	0.0
1:08 PM	2.6	3.1	2.0	1.4	1.8	0.0
1:28 PM	2.6	2.9	1.5	1.2	1.7	0.0
2:00 PM	2.7	2.7	1.3	1.0	1.5	0.0
2:32 PM	2.9	2.6	1.0	1.2	1.7	0.0
3:00 PM	3.0	2.9	1.1	1.5	1.3	0.0
3:29 PM	3.3	3.1	1.4	1.7	1.7	0.0
4:02 PM	3.8	3.6	1.6	1.8	1.8	0.0
4:30 PM	3.9	3.8	1.9	1.9	2.0	0.0
5:01 PM	3.9	3.9	2.5	2.4	2.0	0.0
5:15 PM	SINEMET (100mg)					
5:29 PM	3.5	3.6	2.1	2.2	2.0	0.0
6:02 PM	3.3	3.5	2.0	2.1	1.6	0.0
6:30 PM	3.0	2.9	1.9	2.0	1.5	0.0
7:00 PM	2.8	2.5	1.5	1.8	1.3	0.0
7:33 PM	2.6	2.6	1.2	1.5	1.1	0.0
8:04 PM	2.6	2.6	1.0	1.4	0.9	0.0
8:30 PM	2.9	2.8	1.2	1.5	1.1	0.0
9:02 PM	3.3	3.2	1.3	1.6	1.4	0.0
9:33 PM	3.5	3.6	1.6	1.8	1.8	0.0
10:00 PM	3.8	3.9	2.0	1.9	2.1	0.0
Mean	3.2	3.2	1.6	1.7	1.6	0.0
Fluctuation	0.4	0.5	0.5	0.4	0.4	0.0

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Task-Based Motor Assessments

Kinesia one

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
7:01 AM	4.0	3.5	2.5	2.4	2.2	0.0
7:02 AM	SINEMET (100mg)					
7:32 AM	3.4	3.3	1.7	1.4	1.0	0.0
8:01 AM	3.0	3.0	1.8	1.8	1.2	0.0
8:34 AM	2.9	2.8	1.3	1.2	1.0	0.0
9:00 AM	2.8	2.4	1.2	1.1	1.2	0.0
9:23 AM	2.8	2.6	1.0	1.0	1.0	0.0
10:00 AM	2.6	2.8	1.0	1.0	1.0	0.0
10:33 AM	3.2	3.3	1.5	1.9	1.5	0.0
11:01 AM	3.5	3.5	2.3	2.2	2.0	0.0
11:30 AM	3.7	3.8	2.0	2.0	1.8	0.0
12:00 PM	SINEMET (100mg)					
12:01 PM	3.3	3.8	2.6	2.7	2.0	0.0
12:32 PM	3.2	3.4	1.8	1.9	2.0	0.0
1:08 PM	2.6	3.1	2.0	1.4	1.8	0.0
1:28 PM	2.6	2.9	1.5	1.2	1.7	0.0
2:00 PM	2.7	2.7	1.3	1.0	1.5	0.0
2:32 PM	2.9	2.6	1.0	1.2	1.7	0.0
3:00 PM	3.0	2.9	1.1	1.5	1.3	0.0
3:29 PM	3.3	3.1	1.4	1.7	1.7	0.0
4:02 PM	3.8	3.6	1.6	1.8	1.8	0.0
4:30 PM	3.9	3.8	1.9	1.9	2.0	0.0
5:01 PM	3.9	3.9	2.5	2.4	2.0	0.0
5:15 PM	SINEMET (100mg)					
5:29 PM	3.5	3.6	2.1	2.2	2.0	0.0
6:02 PM	3.3	3.5	2.0	2.1	1.6	0.0
6:30 PM	3.0	2.9	1.9	2.0	1.5	0.0
7:00 PM	2.8	2.5	1.5	1.8	1.3	0.0
7:33 PM	2.6	2.6	1.2	1.5	1.1	0.0
8:04 PM	2.6	2.6	1.0	1.4	0.9	0.0
8:30 PM	2.9	2.8	1.2	1.5	1.1	0.0
9:02 PM	3.3	3.2	1.3	1.6	1.4	0.0
9:33 PM	3.5	3.6	1.6	1.8	1.8	0.0
10:00 PM	3.8	3.9	2.0	1.9	2.1	0.0
Mean	3.2	3.2	1.6	1.7	1.6	0.0
Fluctuation	0.4	0.5	0.5	0.4	0.4	0.0

Increase dose by 200mg, Dose interval unchanged

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
6:55 AM	3.9	3.4	2.6	2.5	2.3	0.0
6:57 AM	SINEMET (300mg)					
7:28 AM	2.5	3.0	1.7	1.4	1.0	0.0
7:59 AM	0.5	1.9	1.8	1.5	1.2	1.3
8:30 AM	0.3	0.9	0.3	0.5	1.0	2.9
9:05 AM	0.1	0.5	0.2	0.2	1.2	3.5
9:33 AM	0.3	0.4	0.0	0.0	1.0	3.8
10:02 AM	0.5	0.1	0.5	0.3	1.0	3.7
10:31 AM	1.5	2.0	1.0	0.5	1.5	2.9
10:58 AM	3.0	3.1	2.3	2.2	2.0	0.0
11:35 AM	3.5	3.4	2.0	2.0	1.8	0.0
11:50 PM	SINEMET (300mg)					
11:56 PM	1.1	2.7	2.3	2.2	2.0	0.0
12:30 PM	0.2	2.0	1.8	1.9	2.0	3.0
1:04 PM	0.1	1.4	2.0	1.4	1.8	3.3
1:38 PM	0.0	1.1	0.8	0.9	1.7	3.5
2:02 PM	0.0	1.0	0.6	1.0	1.5	3.6
2:30 PM	0.2	1.0	1.0	1.2	1.7	2.4
3:07 PM	0.4	0.7	1.1	1.5	1.3	1.1
3:33 PM	0.5	1.3	1.4	1.7	1.7	0.0
4:03 PM	2.6	1.5	1.6	1.8	1.8	0.0
4:28 PM	3.5	2.0	1.9	1.9	2.0	0.0
5:00 PM	3.8	2.2	2.1	2.1	2.0	0.0
5:05 PM	SINEMET (300mg)					
5:39 PM	3.5	2.2	2.1	2.2	2.0	0.0
6:03 PM	2.3	2.0	2.0	2.1	1.6	0.0
6:29 PM	1.7	1.3	1.9	2.0	1.5	0.5
7:05 PM	0.8	1.1	1.5	1.8	1.3	1.0
7:36 PM	0.6	0.8	1.2	1.5	1.1	2.3
8:01 PM	0.3	0.6	1.0	1.4	0.9	3.8
8:28 PM	0.2	1.0	1.2	1.5	1.1	3.7
9:00 PM	0.3	1.1	1.3	1.6	1.4	1.3
9:34 PM	0.3	2.0	1.6	1.8	1.8	0.5
9:59 PM	2.8	2.3	2.0	1.9	2.1	0.0
Mean	1.3	1.6	1.4	1.5	1.6	1.6
Fluctuation	1.3	0.9	0.7	0.6	0.4	1.5

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Task-Based Motor Assessments

Kinesia one

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
7:01 AM	4.0	3.5	2.5	2.4	2.2	0.0
7:02 AM	SINEMET (100mg)					
7:32 AM	3.4	3.3	1.7	1.4	1.0	0.0
8:01 AM	3.0	3.0	1.8	1.8	1.2	0.0
8:34 AM	2.9	2.8	1.3	1.2	1.0	0.0
9:00 AM	2.8	2.4	1.2	1.1	1.2	0.0
9:23 AM	2.8	2.6	1.0	1.0	1.0	0.0
10:00 AM	2.6	2.8	1.0	1.0	1.0	0.0
10:33 AM	3.2	3.3	1.5	1.9	1.5	0.0
11:01 AM	3.5	3.5	2.3	2.2	2.0	0.0
11:30 AM	3.7	3.8	2.0	2.0	1.8	0.0
12:00 PM	SINEMET (100mg)					
12:01 PM	3.3	3.8	2.6	2.7	2.0	0.0
12:32 PM	3.2	3.4	1.8	1.9	2.0	0.0
1:08 PM	2.6	3.1	2.0	1.4	1.8	0.0
1:28 PM	2.6	2.9	1.5	1.2	1.7	0.0
2:00 PM	2.7	2.7	1.3	1.0	1.5	0.0
2:32 PM	2.9	2.6	1.0	1.2	1.7	0.0
3:00 PM	3.0	2.9	1.1	1.5	1.3	0.0
3:29 PM	3.3	3.1	1.4	1.7	1.7	0.0
4:02 PM	3.8	3.6	1.6	1.8	1.8	0.0
4:30 PM	3.9	3.8	1.9	1.9	2.0	0.0
5:01 PM	3.9	3.9	2.5	2.4	2.0	0.0
5:15 PM	SINEMET (100mg)					
5:29 PM	3.5	3.6	2.1	2.2	2.0	0.0
6:02 PM	3.3	3.5	2.0	2.1	1.6	0.0
6:30 PM	3.0	2.9	1.9	2.0	1.5	0.0
7:00 PM	2.8	2.5	1.5	1.8	1.3	0.0
7:33 PM	2.6	2.6	1.2	1.5	1.1	0.0
8:04 PM	2.6	2.6	1.0	1.4	0.9	0.0
8:30 PM	2.9	2.8	1.2	1.5	1.1	0.0
9:02 PM	3.3	3.2	1.3	1.6	1.4	0.0
9:33 PM	3.5	3.6	1.6	1.8	1.8	0.0
10:00 PM	3.8	3.9	2.0	1.9	2.1	0.0
Mean	3.2	3.2	1.6	1.7	1.6	0.0
Fluctuation	0.4	0.5	0.5	0.4	0.4	0.0

Increase dose by 200mg, Dose interval unchanged

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
6:55 AM	3.9	3.4	2.6	2.5	2.3	0.0
6:57 AM	SINEMET (300mg)					
7:28 AM	2.5	3.0	1.7	1.4	1.0	0.0
7:59 AM	0.5	1.9	1.8	1.5	1.2	1.3
8:30 AM	0.3	0.9	0.3	0.5	1.0	2.9
9:05 AM	0.1	0.5	0.2	0.2	1.2	3.5
9:33 AM	0.3	0.4	0.0	0.0	1.0	3.8
10:02 AM	0.5	0.1	0.5	0.3	1.0	3.7
10:31 AM	1.5	2.0	1.0	0.5	1.5	2.9
10:58 AM	3.0	3.1	2.3	2.2	2.0	0.0
11:35 AM	3.5	3.4	2.0	2.0	1.8	0.0
11:50 PM	SINEMET (300mg)					
11:56 PM	1.1	2.7	2.3	2.2	2.0	0.0
12:30 PM	0.2	2.0	1.8	1.9	2.0	3.0
1:04 PM	0.1	1.4	2.0	1.4	1.8	3.3
1:38 PM	0.0	1.1	0.8	0.9	1.7	3.5
2:02 PM	0.0	1.0	0.6	1.0	1.5	3.6
2:30 PM	0.2	1.0	1.0	1.2	1.7	2.4
3:07 PM	0.4	0.7	1.1	1.5	1.3	1.1
3:33 PM	0.5	1.3	1.4	1.7	1.7	0.0
4:03 PM	2.6	1.5	1.6	1.8	1.8	0.0
4:28 PM	3.5	2.0	1.9	1.9	2.0	0.0
5:00 PM	3.8	2.2	2.1	2.1	2.0	0.0
5:05 PM	SINEMET (300mg)					
5:39 PM	3.5	2.2	2.1	2.2	2.0	0.0
6:03 PM	2.3	2.0	2.0	2.1	1.6	0.0
6:29 PM	1.7	1.3	1.9	2.0	1.5	0.5
7:05 PM	0.8	1.1	1.5	1.8	1.3	1.0
7:36 PM	0.6	0.8	1.2	1.5	1.1	2.3
8:01 PM	0.3	0.6	1.0	1.4	0.9	3.8
8:28 PM	0.2	1.0	1.2	1.5	1.1	3.7
9:00 PM	0.3	1.1	1.3	1.6	1.4	1.3
9:34 PM	0.3	2.0	1.6	1.8	1.8	0.5
9:59 PM	2.8	2.3	2.0	1.9	2.1	0.0
Mean	1.3	1.6	1.4	1.5	1.6	1.6
Fluctuation	1.3	0.9	0.7	0.6	0.4	1.5

Decrease dose by 100mg, Decrease dose interval by 2 hours

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
7:00 AM	3.5	3.2	2.7	2.5	2.4	0.0
7:01 AM	SINEMET (200mg)					
7:31 AM	2.0	2.1	1.9	2.1	2.2	0.0
8:00 AM	0.6	0.7	0.3	0.5	1.0	0.0
8:33 AM	0.3	0.5	0.2	0.2	1.2	0.0
8:59 AM	0.2	0.2	0.0	0.0	1.0	0.0
9:22 AM	0.2	0.0	0.5	0.3	1.0	0.0
9:59 AM	1.1	1.5	1.0	0.5	1.5	0.0
10:32 AM	SINEMET (200mg)					
11:00 AM	1.2	1.3	1.5	1.4	1.5	0.0
11:29 AM	0.3	0.3	0.5	0.6	2.1	0.0
11:59 PM	0.2	0.2	0.3	0.3	1.0	0.0
12:00 PM	0.1	0.0	0.4	0.1	2.3	0.0
12:31 PM	0.2	0.6	0.6	0.1	2.1	0.0
1:07 PM	1.2	1.6	1.7	1.6	1.7	0.0
1:27 PM	SINEMET (200mg)					
1:59 PM	1.0	0.8	1.0	0.9	1.0	0.0
2:31 PM	0.3	0.7	0.3	0.8	0.9	0.0
2:59 PM	0.2	0.5	0.2	0.5	0.9	0.0
3:28 PM	0.0	0.3	0.2	0.8	0.9	0.0
4:01 PM	0.5	0.8	0.9	1.6	1.7	0.0
4:29 PM	1.3	1.7	1.6	2.1	2.1	0.0
5:00 PM	SINEMET (200mg)					
5:14 PM	1.0	1.5	1.0	0.9	1.0	0.0
5:28 PM	0.3	0.6	0.3	0.8	2.4	0.0
6:01 PM	0.2	0.3	0.2	0.5	2.0	0.0
6:29 PM	0.0	0.0	0.2	0.8	1.7	0.0
6:59 PM	0.5	0.2	0.9	1.6	1.2	0.0
7:32 PM	1.3	0.9	1.6	2.1	1.0	0.0
8:03 PM	SINEMET (200mg)					
8:29 PM	0.8	0.6	0.5	0.7	0.5	0.0
9:01 PM	0.0	0.2	0.2	1.1	0.9	0.0
9:32 PM	0.0	0.1	0.9	1.6	1.3	0.0
9:55 PM	0.5	0.6	1.9	2.0	1.9	0.0
Mean	0.7	0.8	0.8	1.0	1.5	0.0
Fluctuation	0.7	0.7	0.7	0.7	0.5	0.0

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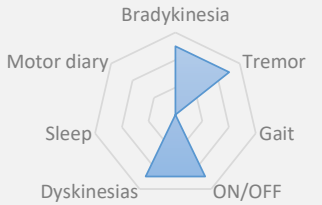
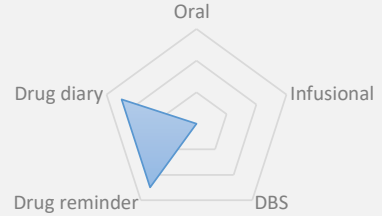
DEVELOPMENT STAGE

CERTIFICATIONS

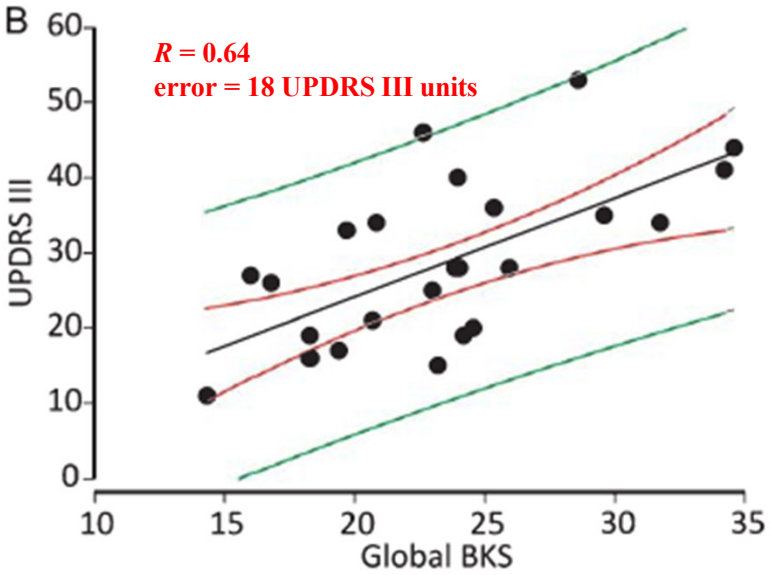
DIAGNOSIS	SYMPTOMS MONITORING	THERAPY MANAGEMENT
✕		

PKG® Remote Monitoring Process

Bradykinesia score (BKS):

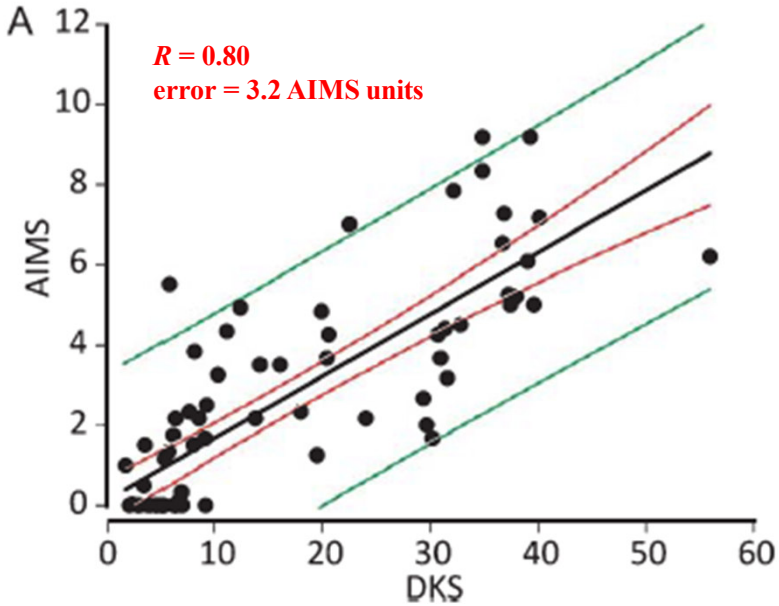
- **Lower Mean Spectral Power (MSP) within 0.2 and 4 Hz**,
- **Lower Peak acceleration**
- **Longer Time whitout movement**.

Bradykinetic subjects move with lower accelerations, amplitude, energy, and with longer intervals between movements than normal subjects.



Dyskinesia score (DKS):

- **Larger Mean Spectral Power (MSP)**
- **Greater Acceleration** than the mean.
- **Shorter Time without movement**.



Griffiths RI, et al. J Parkinsons Dis. 2012;2(1):47-55. doi: 10.3233/JPD-2012-11071. PMID: 23939408.

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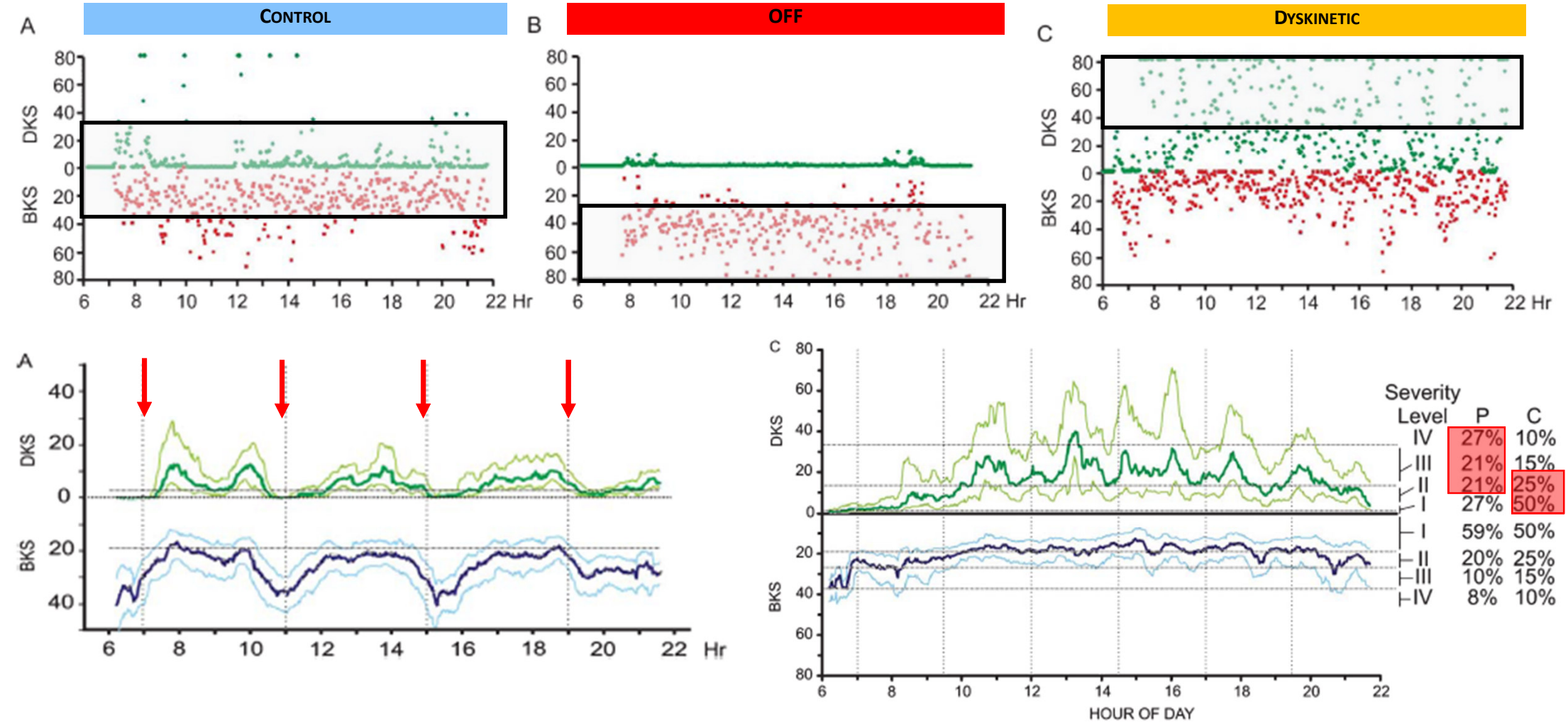
BRADYKINESIA AND DYSKINESIA



Griffiths RI, et al. J Parkinsons Dis. 2012;2(1):47-55. doi: 10.3233/JPD-2012-11071. PMID: 23939408.

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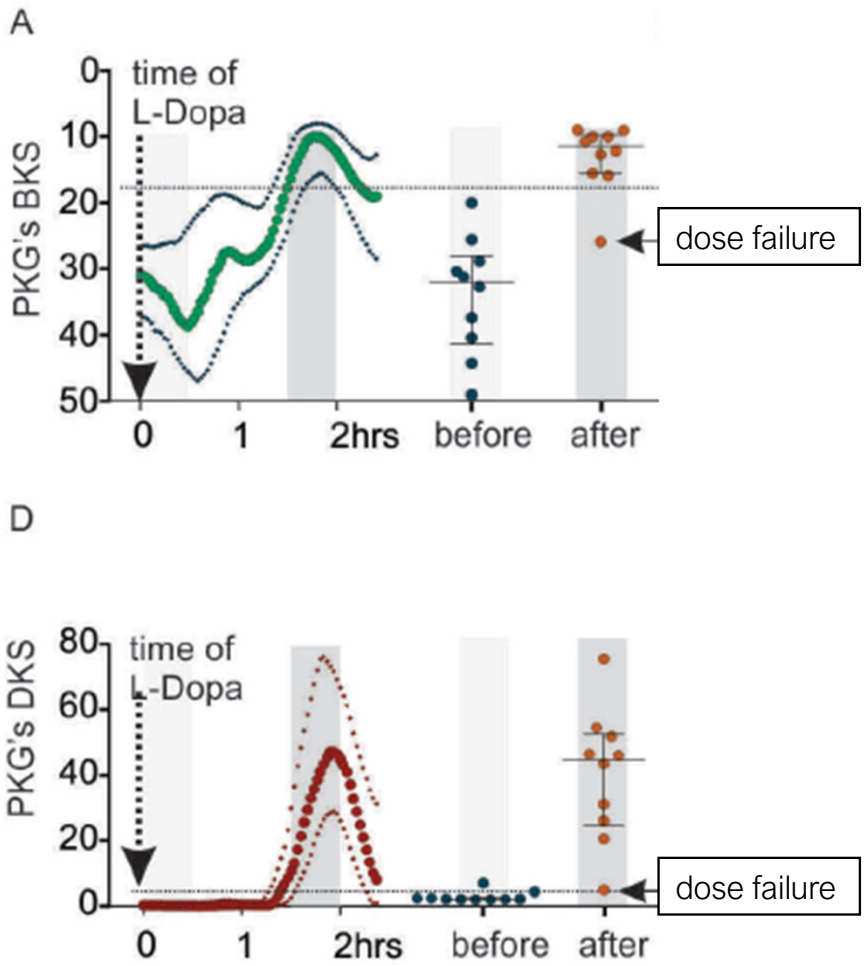
Bradykinesia and Dyskinesia



Horne, M., et al. (2016). In *CNS* (Vol. 2, No. 1, pp. 15-22).

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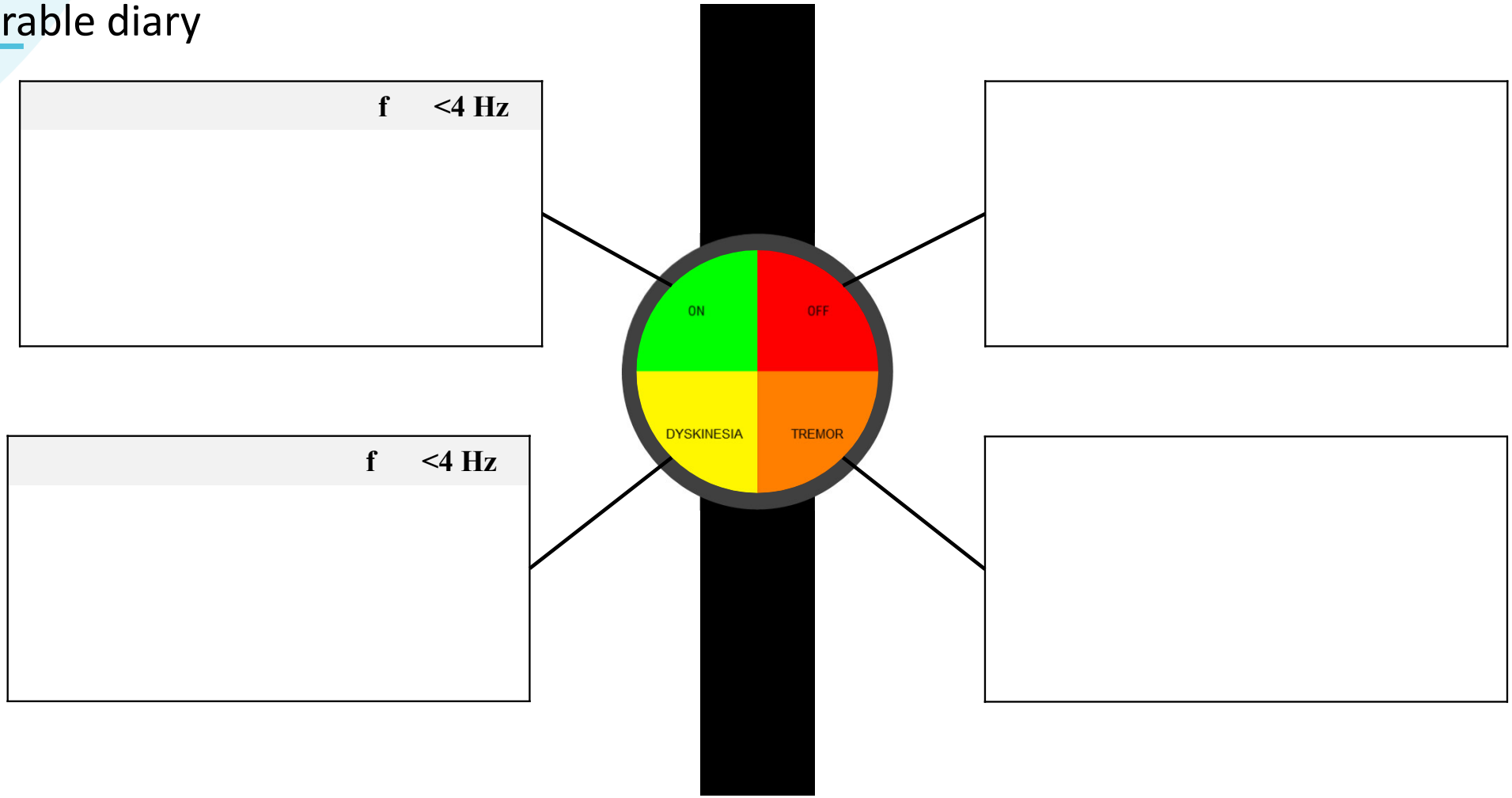
Wearable diary



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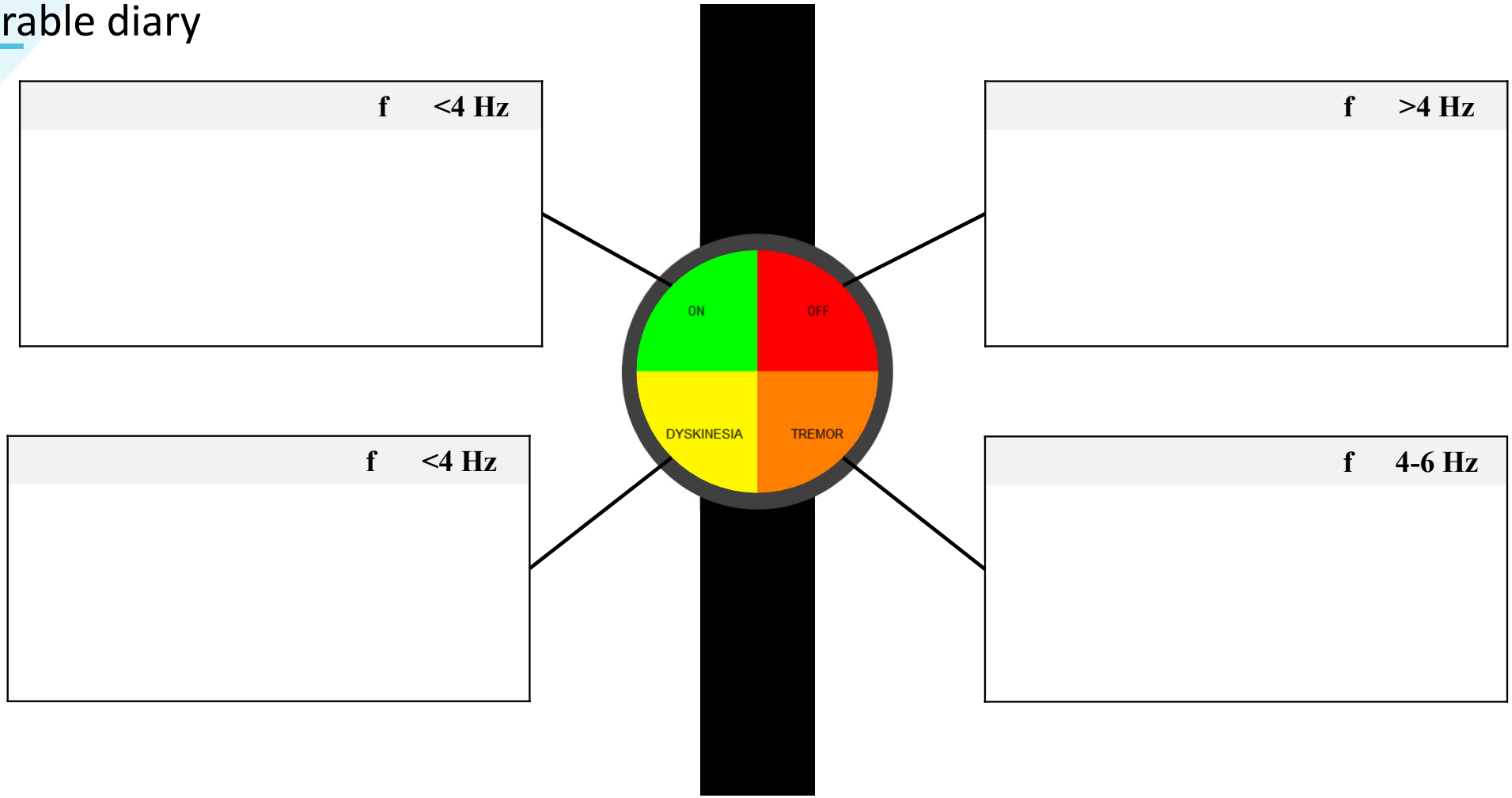
Wearable diary



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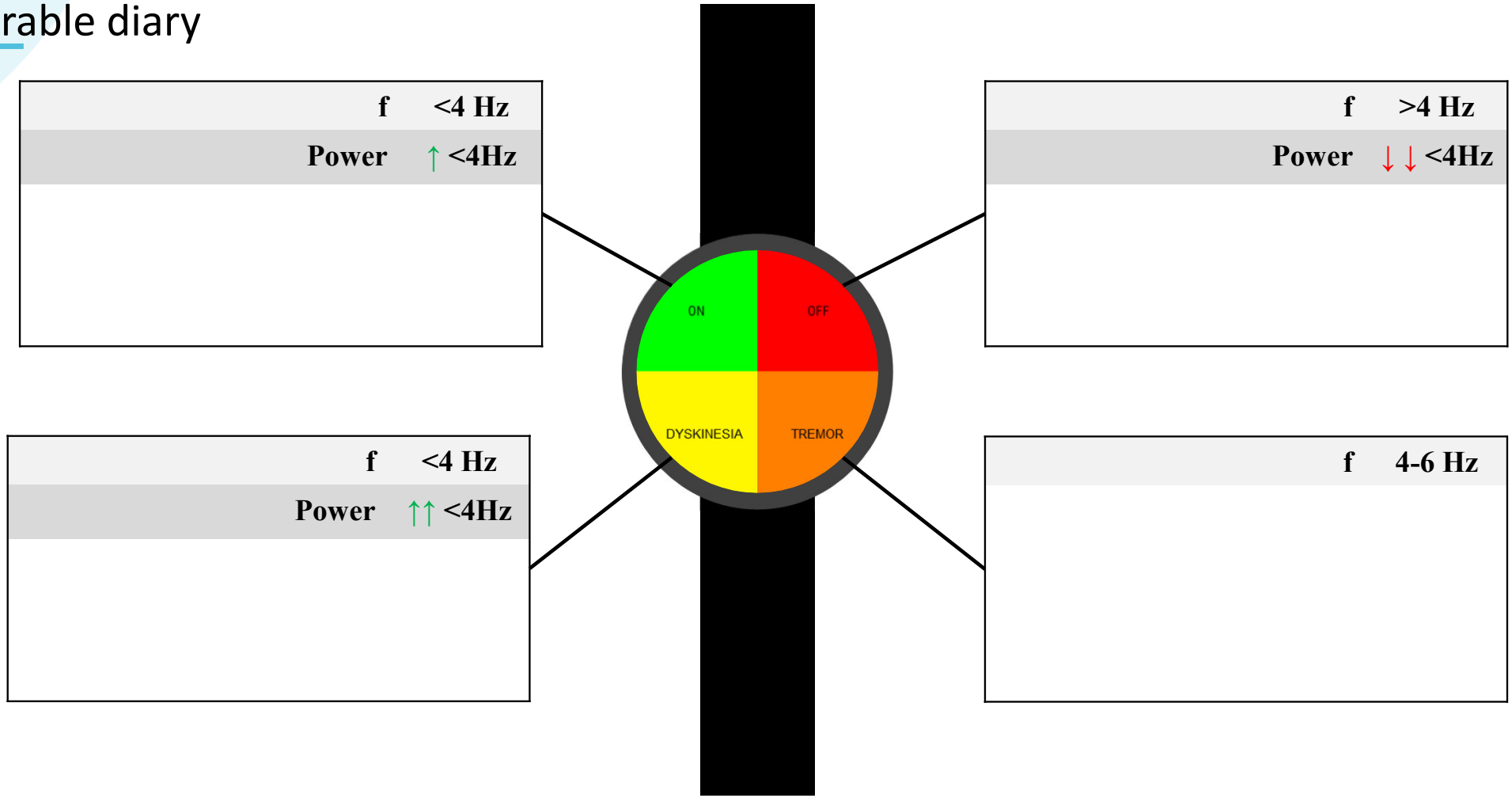
Wearable diary



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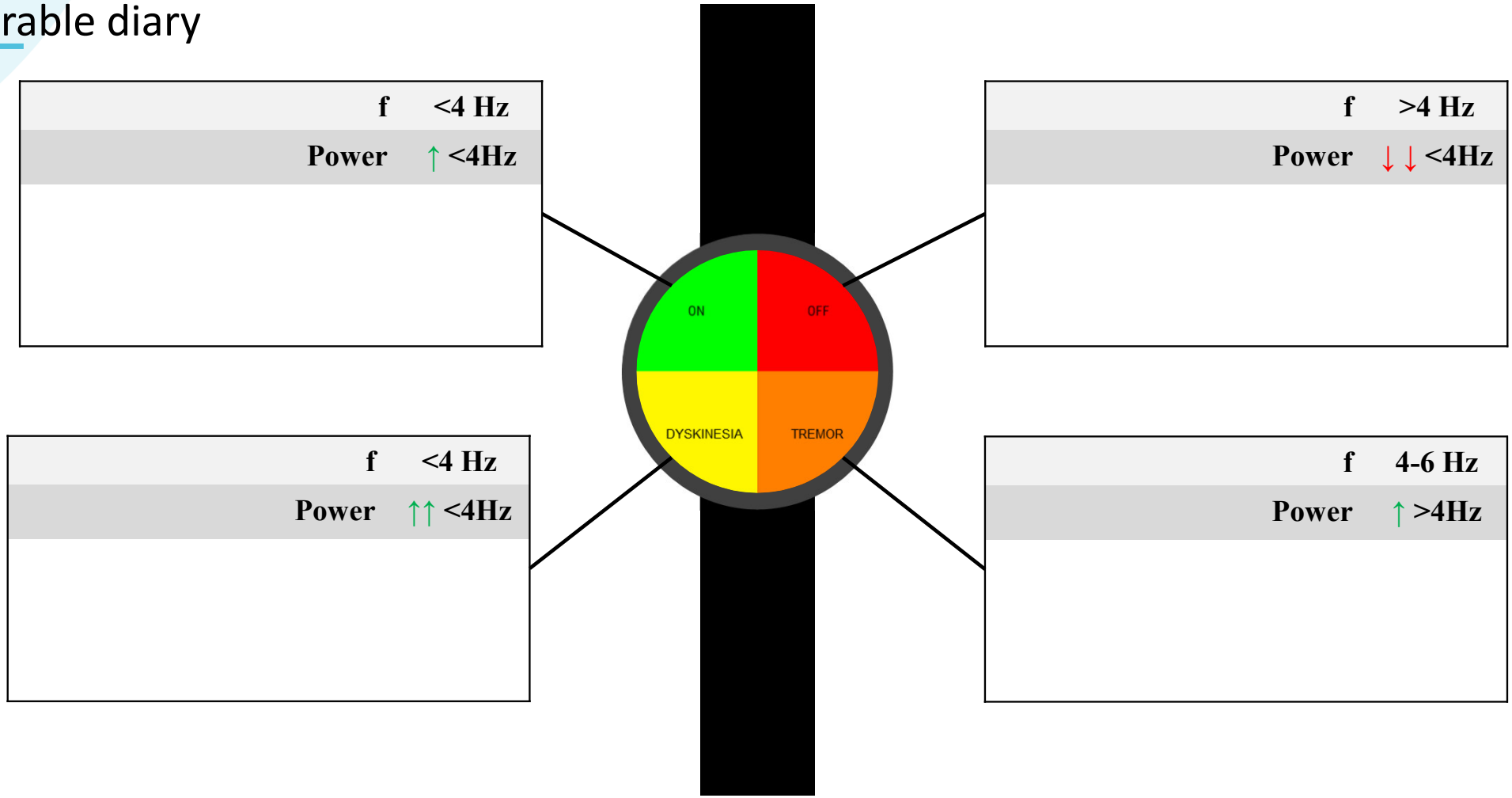
Wearable diary



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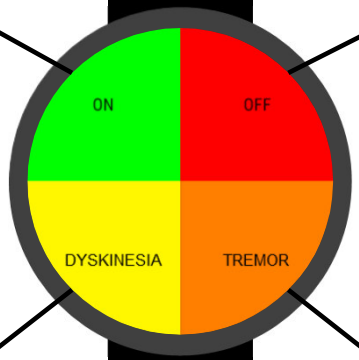
Wearable diary

f	<4 Hz
Power	↑ <4Hz
Angular Velocity (RMS)	↑ <4Hz
Acceleration (RMS)	↑ <4Hz

f	>4 Hz
Power	↓↓ <4Hz
Angular Velocity (RMS)	↓↓ <4Hz
Acceleration (RMS)	↓↓ <4Hz



f	<4 Hz
Power	↑↑ <4Hz
Angular Velocity (RMS)	↑↑ <4Hz
Acceleration (RMS)	↑↑ <4Hz

f	4-6 Hz
Power	↑ >4Hz
Angular Velocity (RMS)	↑ >4Hz
Acceleration (RMS)	↑ >4Hz

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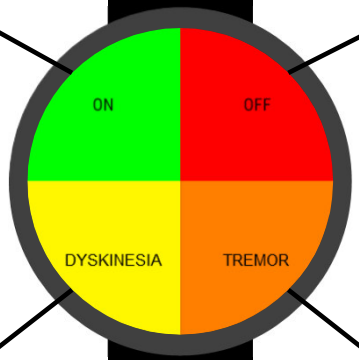
Wearable diary

f	<4 Hz
Power	↑ <4Hz
Angular Velocity (RMS)	↑ <4Hz
Acceleration (RMS)	↑ <4Hz
Time whitout movement	↓

f	>4 Hz
Power	↓↓ <4Hz
Angular Velocity (RMS)	↓↓ <4Hz
Acceleration (RMS)	↓↓ <4Hz
Time whitout movement	↑



f	<4 Hz
Power	↑↑ <4Hz
Angular Velocity (RMS)	↑↑ <4Hz
Acceleration (RMS)	↑↑ <4Hz
Time whitout movement	↓↓↓

f	4-6 Hz
Power	↑ >4Hz
Angular Velocity (RMS)	↑ >4Hz
Acceleration (RMS)	↑ >4Hz
Time whitout movement	↓↓

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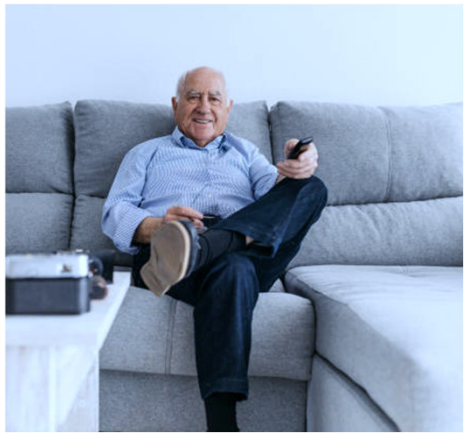
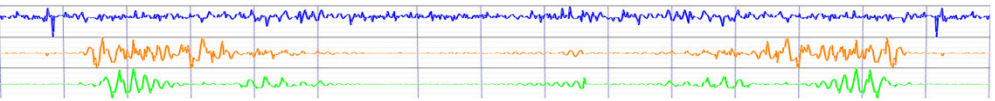
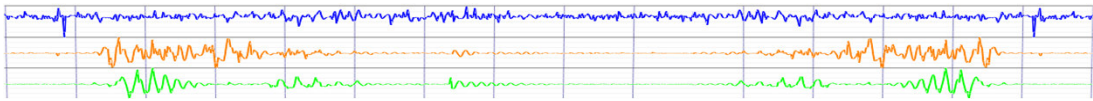
Bradykinesia





Dyskinesia



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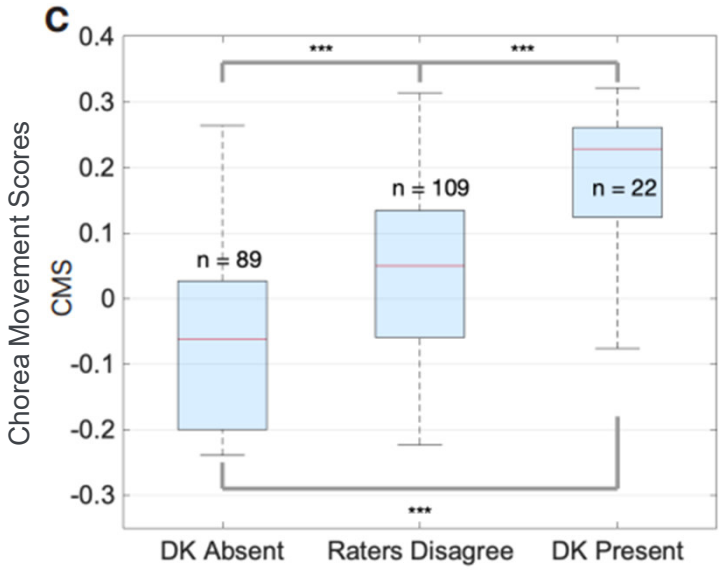
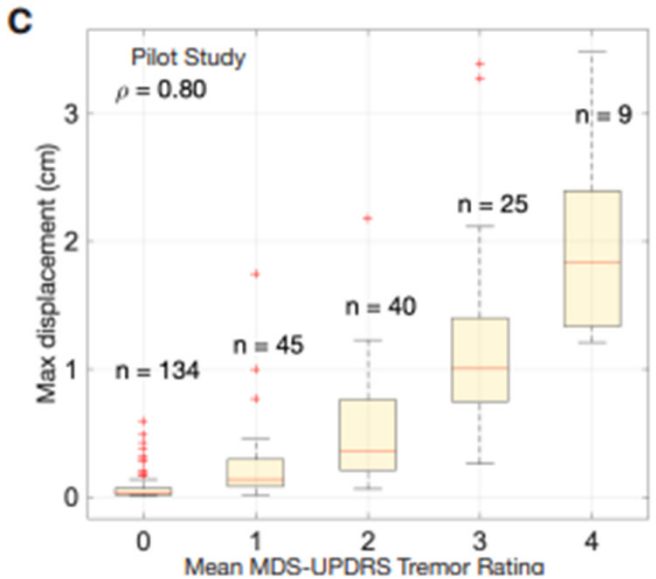
Apple Movement Disorder API





Activity	% Tremor	% Chorea
Walking	2%	1%
Brushing Teeth (Manual)	8%	4%
Riding Bus	2%	13%
Knitting	0.3%	14%
Cycling	0.4%	31%
Musical Instrument	2%	61%

Powers R,et al. Smartwatch inertial sensors continuously monitor real-world motor fluctuations in Parkinson's disease. Sci Transl Med. 2021. doi: 10.1126/scitranslmed.abd7865.

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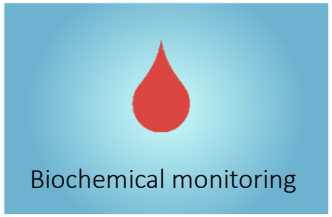
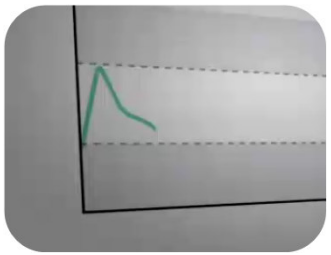
Biochemical monitoring





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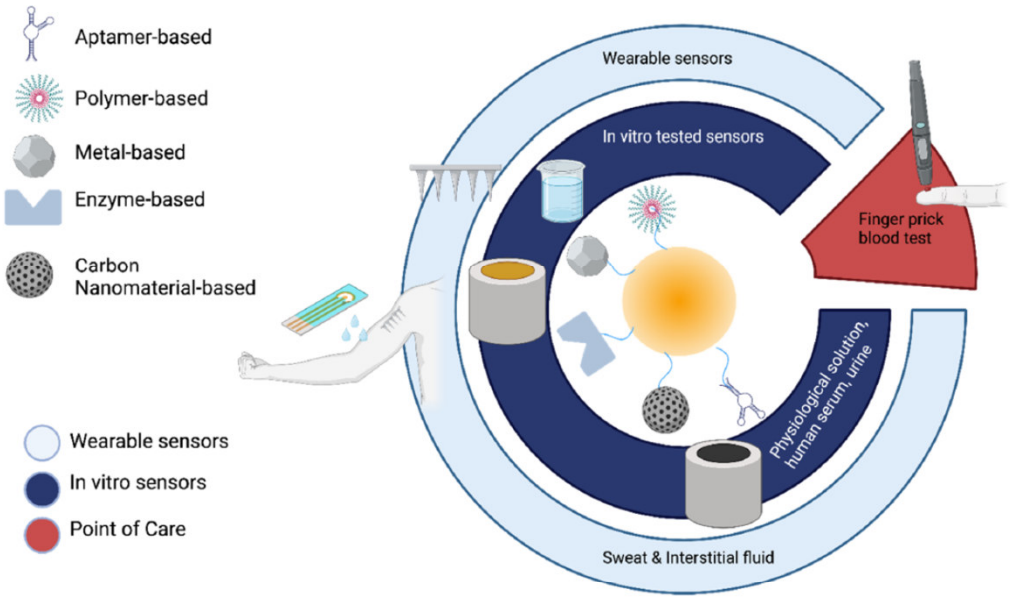

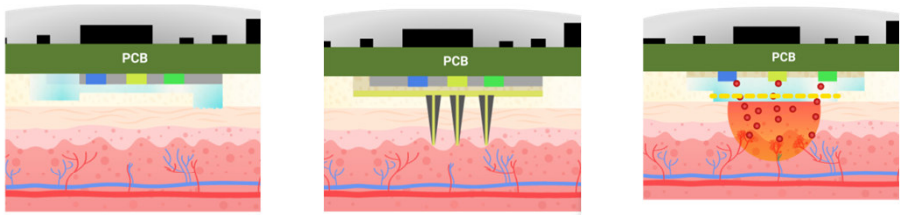

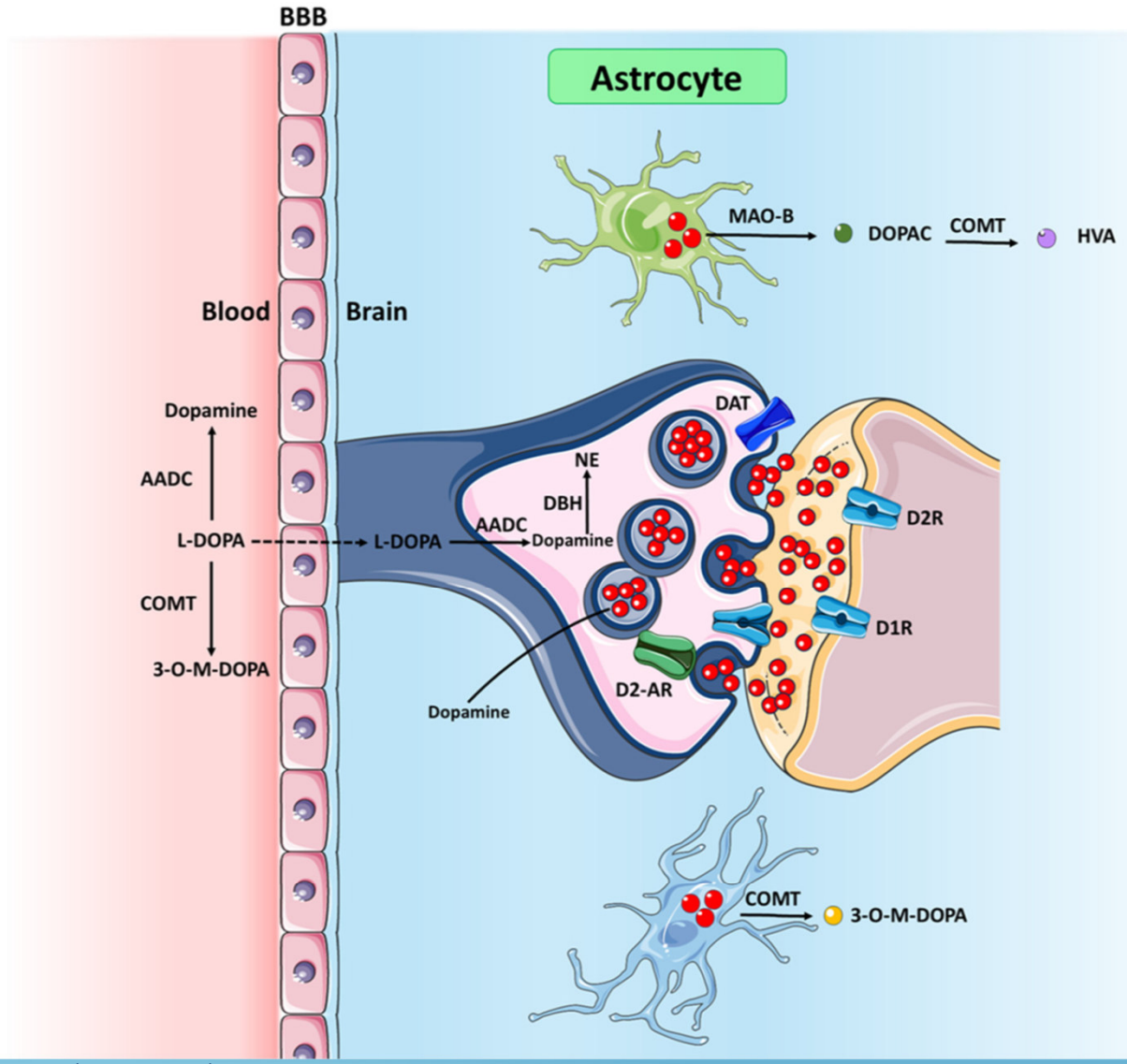

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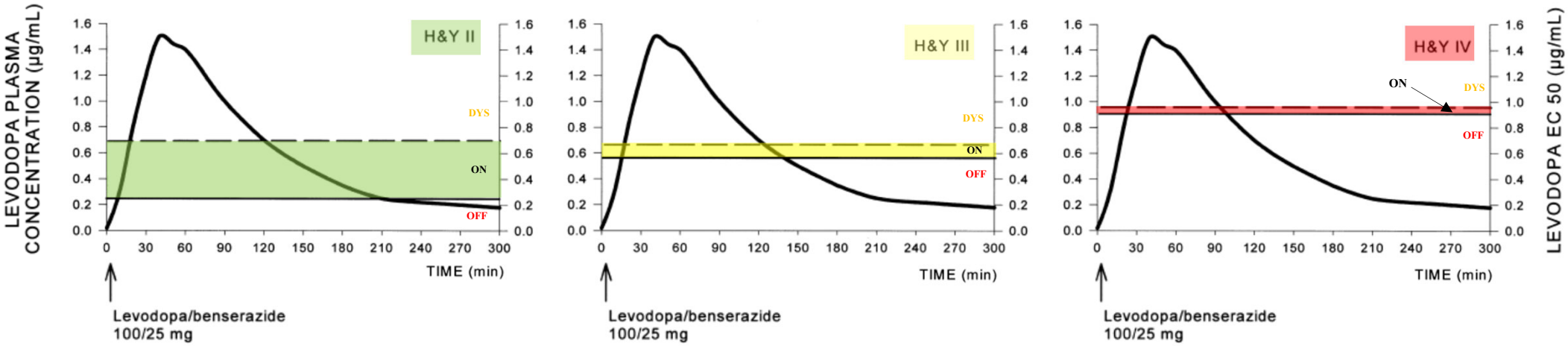
Pharmacokinetics and Pharmacodynamics



Contin M, et al. Ther Drug Monit. 2001 Dec;23(6):621-9. doi: 10.1097/00007691-200112000-00005. PMID: 11802094.

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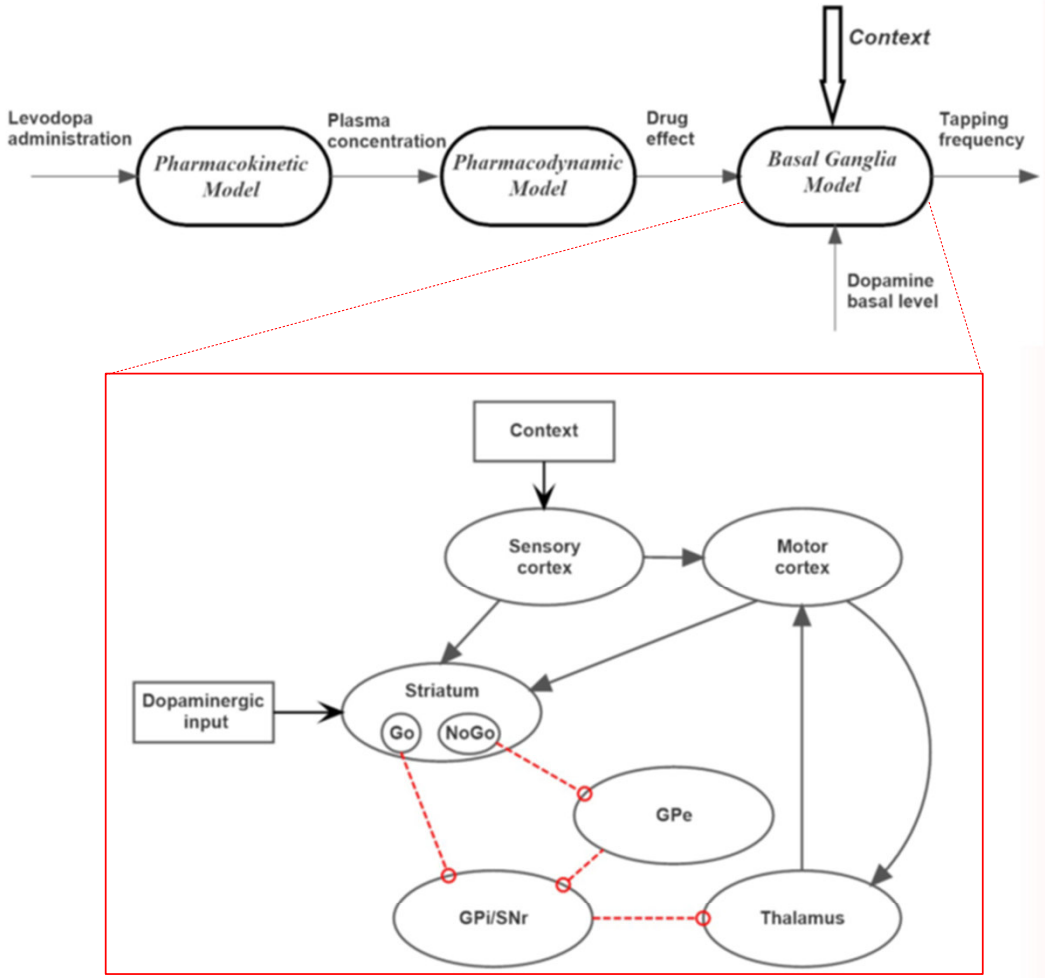

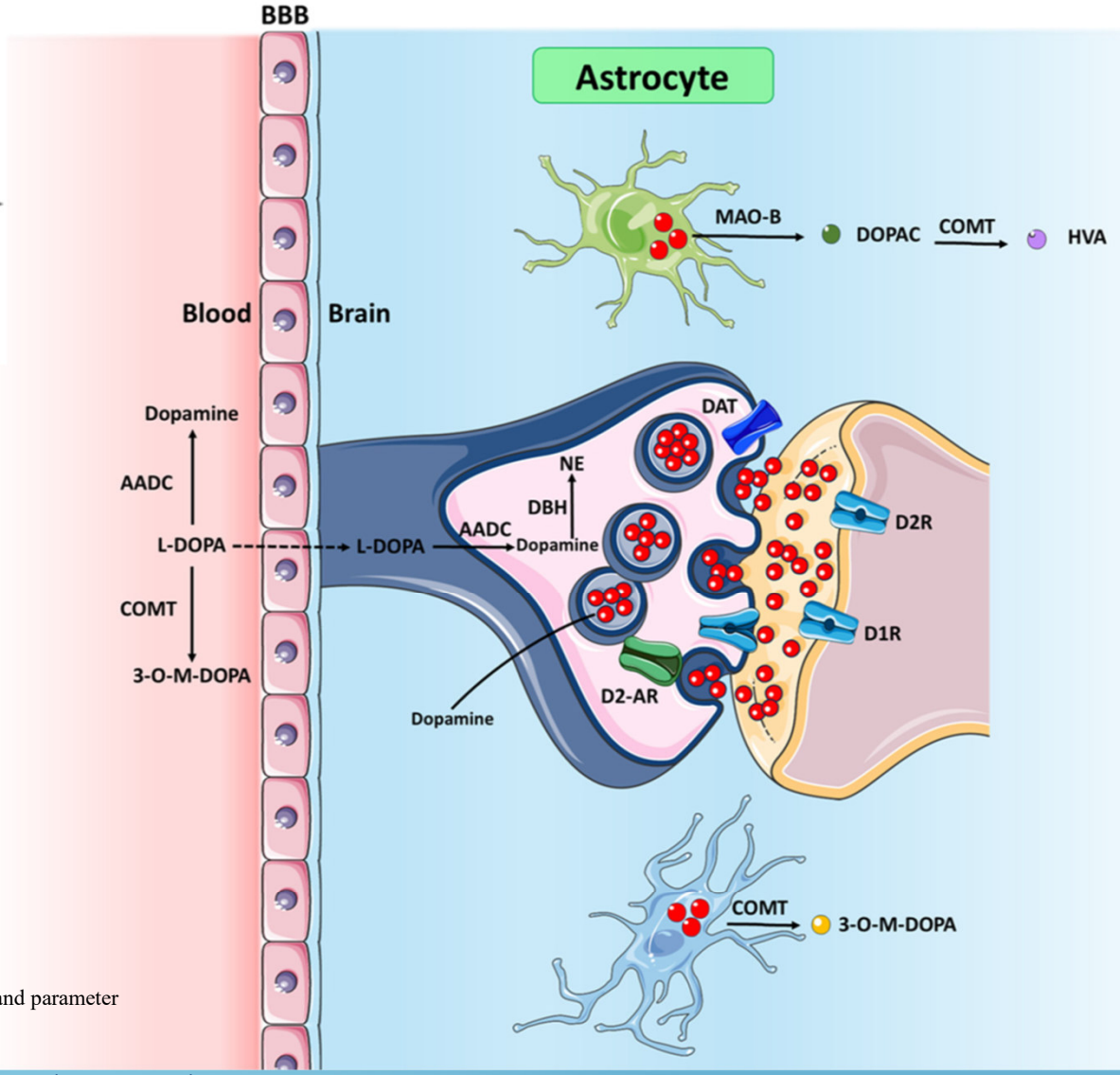

Ursino M, Magosso E, Lopane G, Calandra-Buonaura G, Cortelli P, ContinM (2020) Mathematical modeling and parameter estimation of levodopa motor response in patients with parkinson disease. PLoS ONE 15(3): e0229729 https://doi.org/10.1371/journal.pone.0229729

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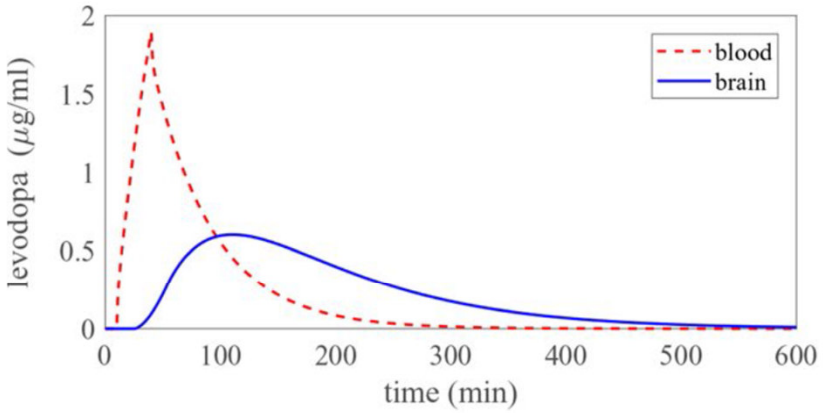
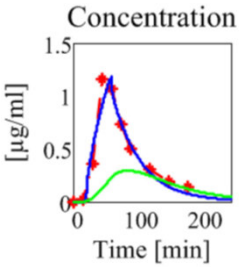
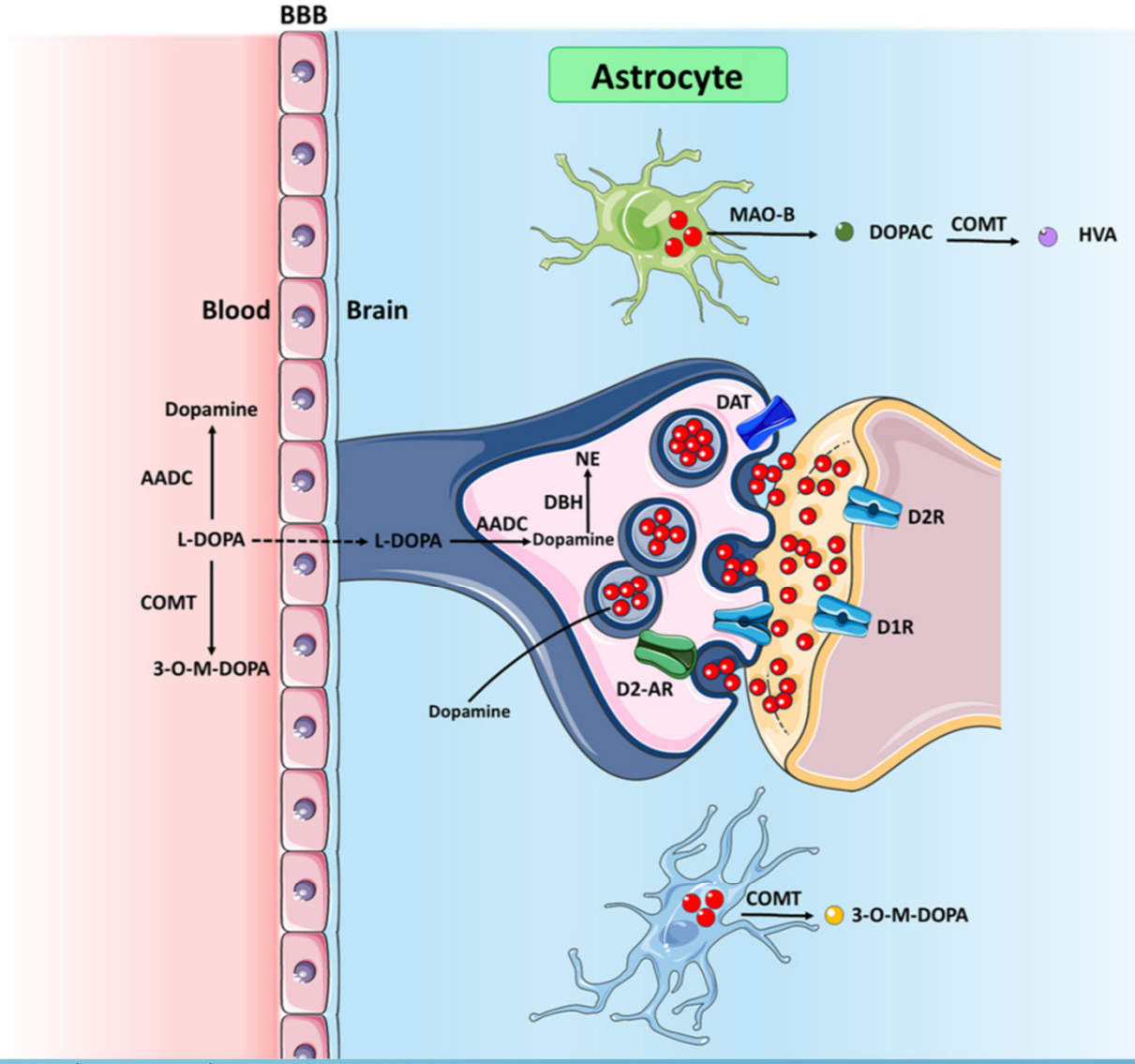


Ursino M, Baston C. Aberrant learning in Parkinson's disease: A neurocomputational study on bradykinesia. *Eur J Neurosci*. 2018;47:1563– 1582. https://doi.org/10.1111/ejn.13960



Baston, C., et al. (2016). *Frontiers in human neuroscience*, *10*, 280.



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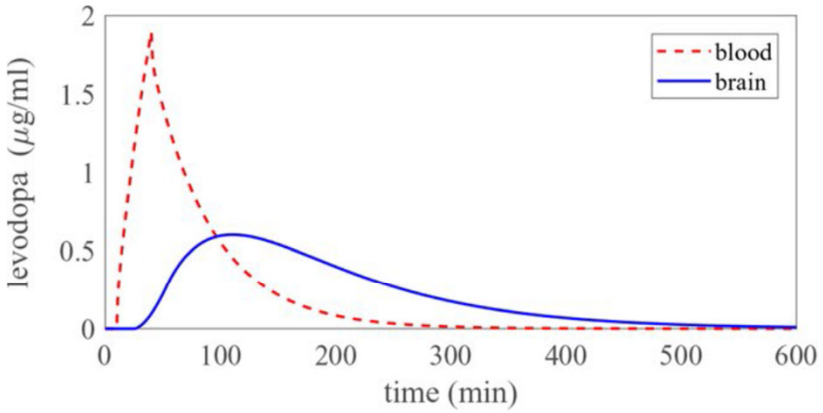
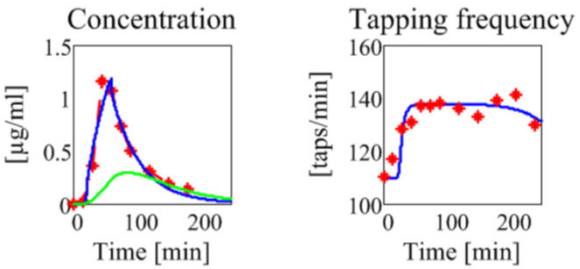
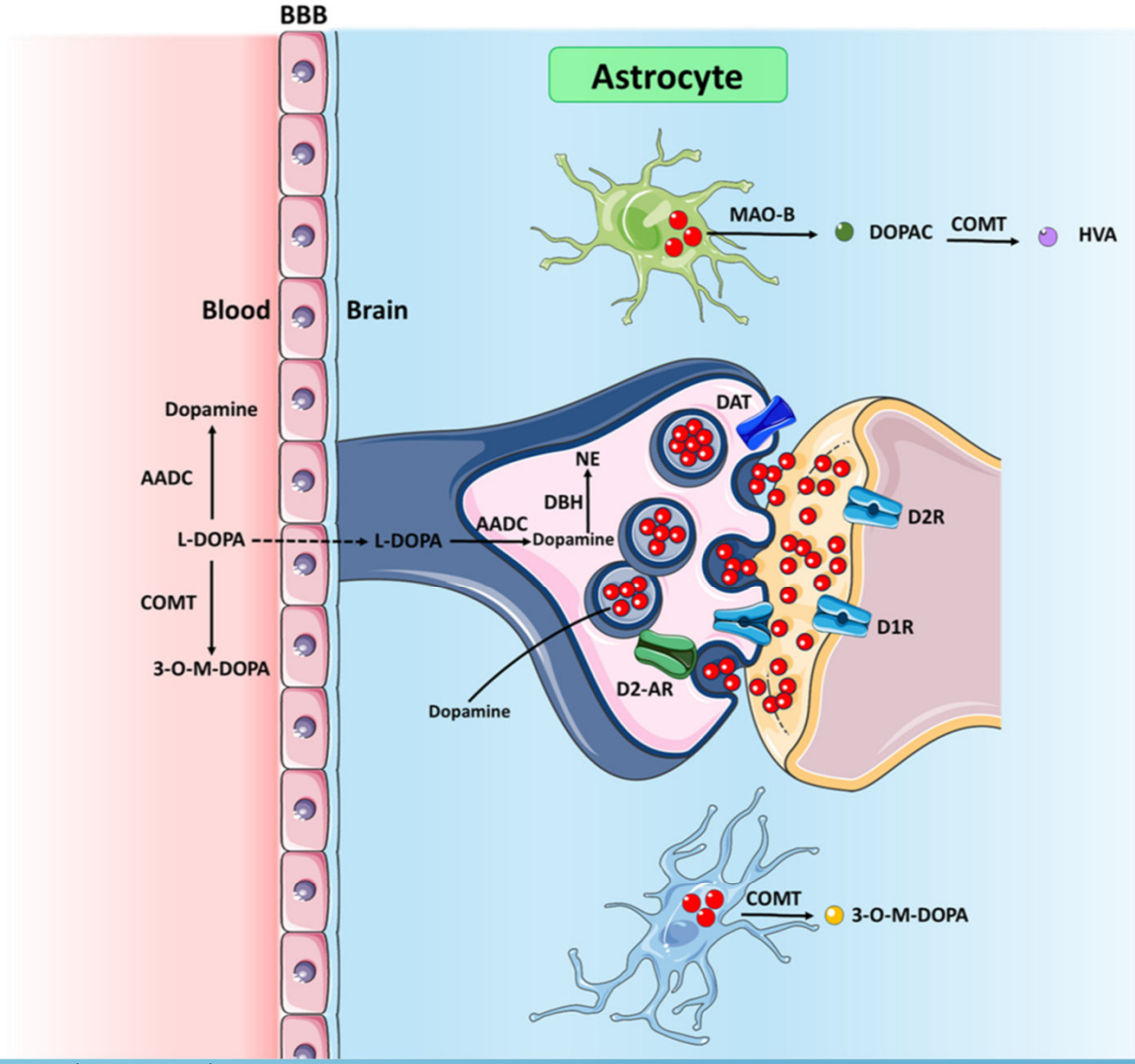


Ursino M, Baston C. Aberrant learning in Parkinson's disease: A neurocomputational study on bradykinesia. *Eur J Neurosci*. 2018;47:1563– 1582. https://doi.org/10.1111/ejn.13960



Baston, C., et al. (2016). *Frontiers in human neuroscience*, *10*, 280.



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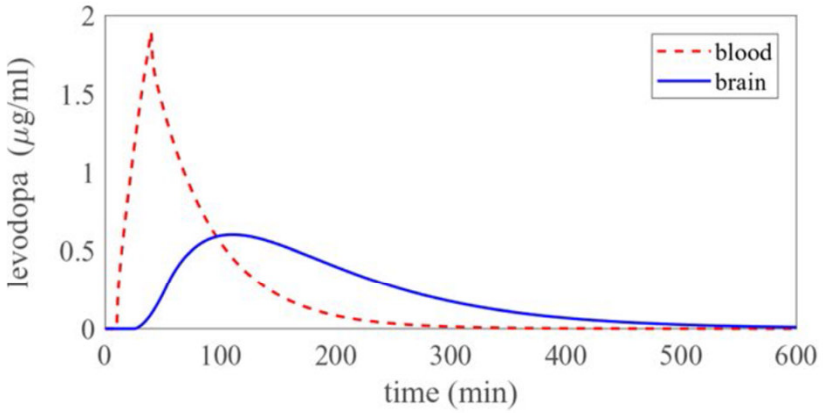

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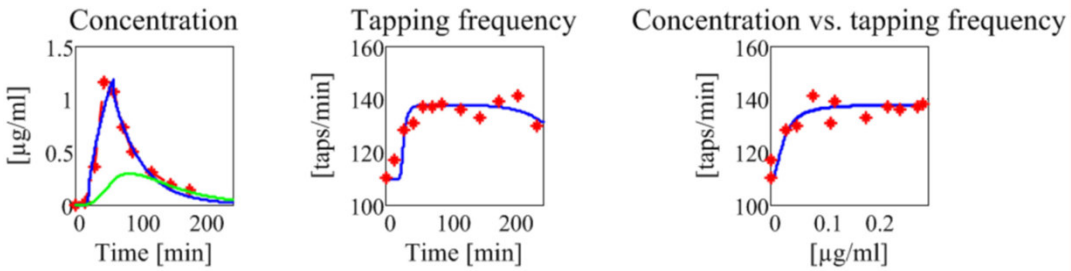
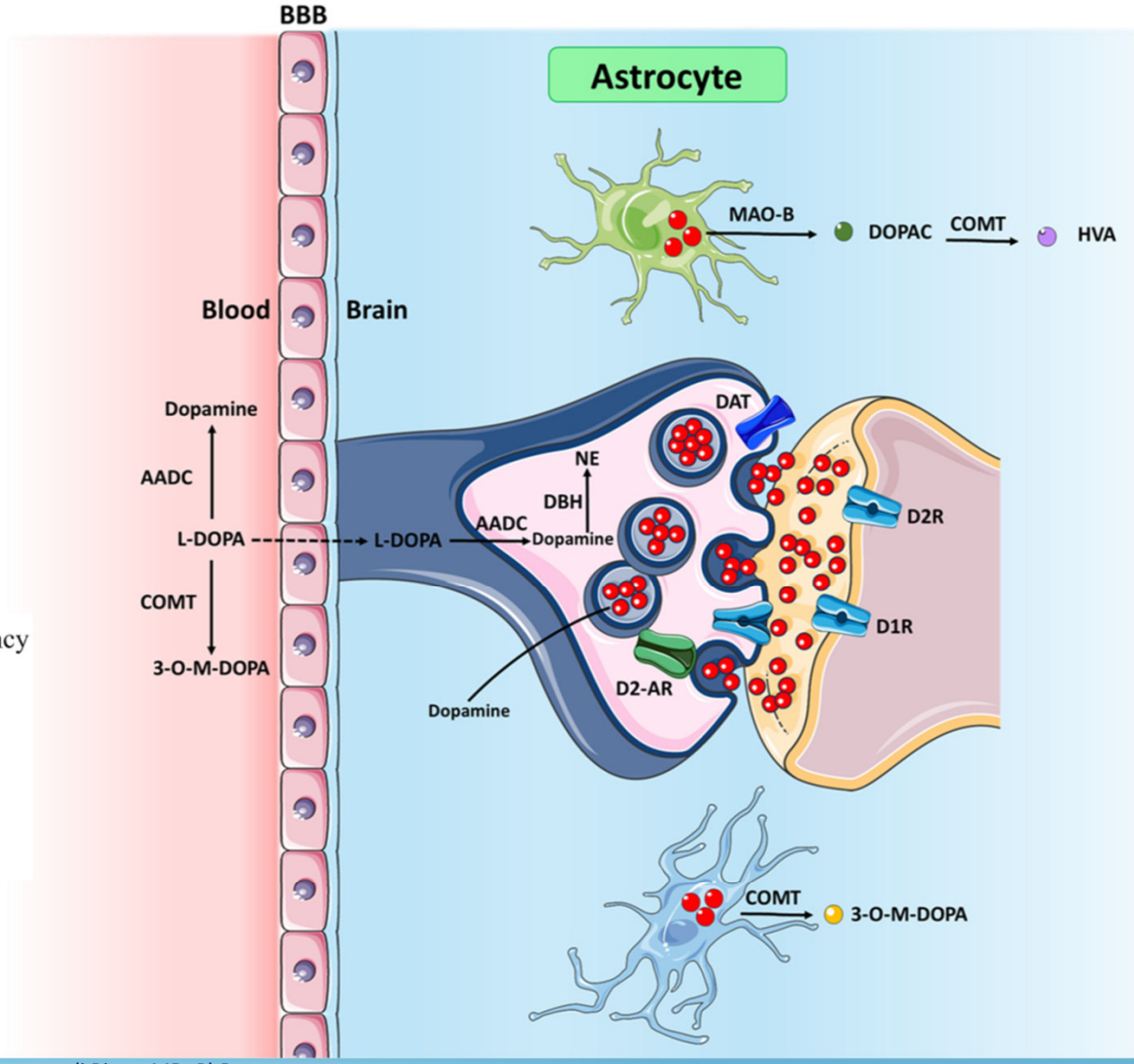


Baston, C., et al. (2016). *Frontiers in human neuroscience*, *10*, 280.



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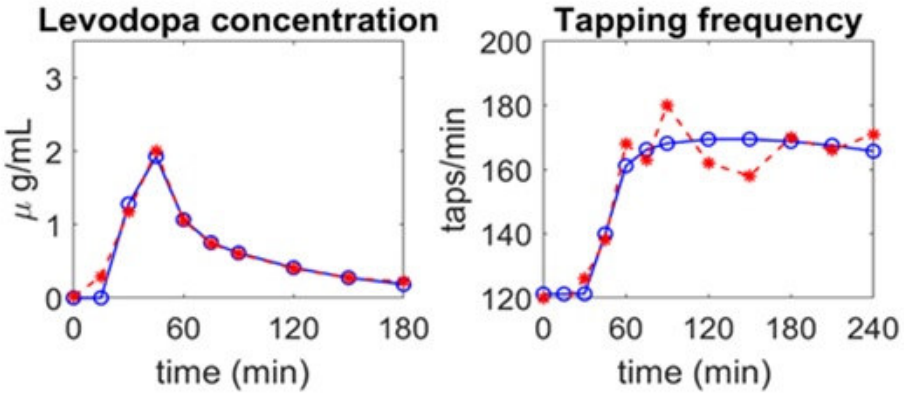
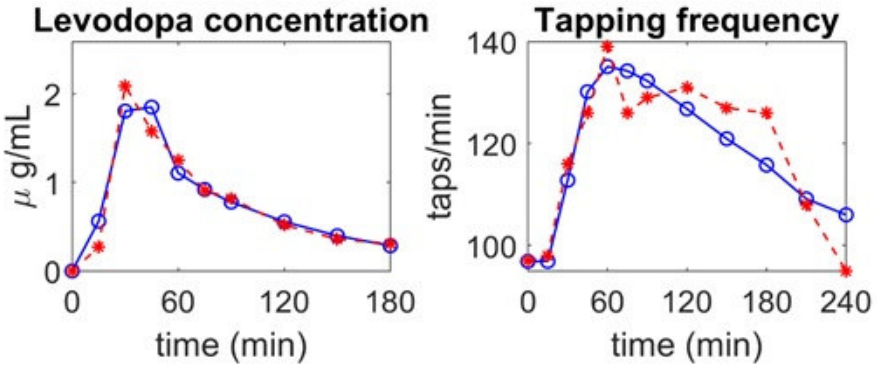
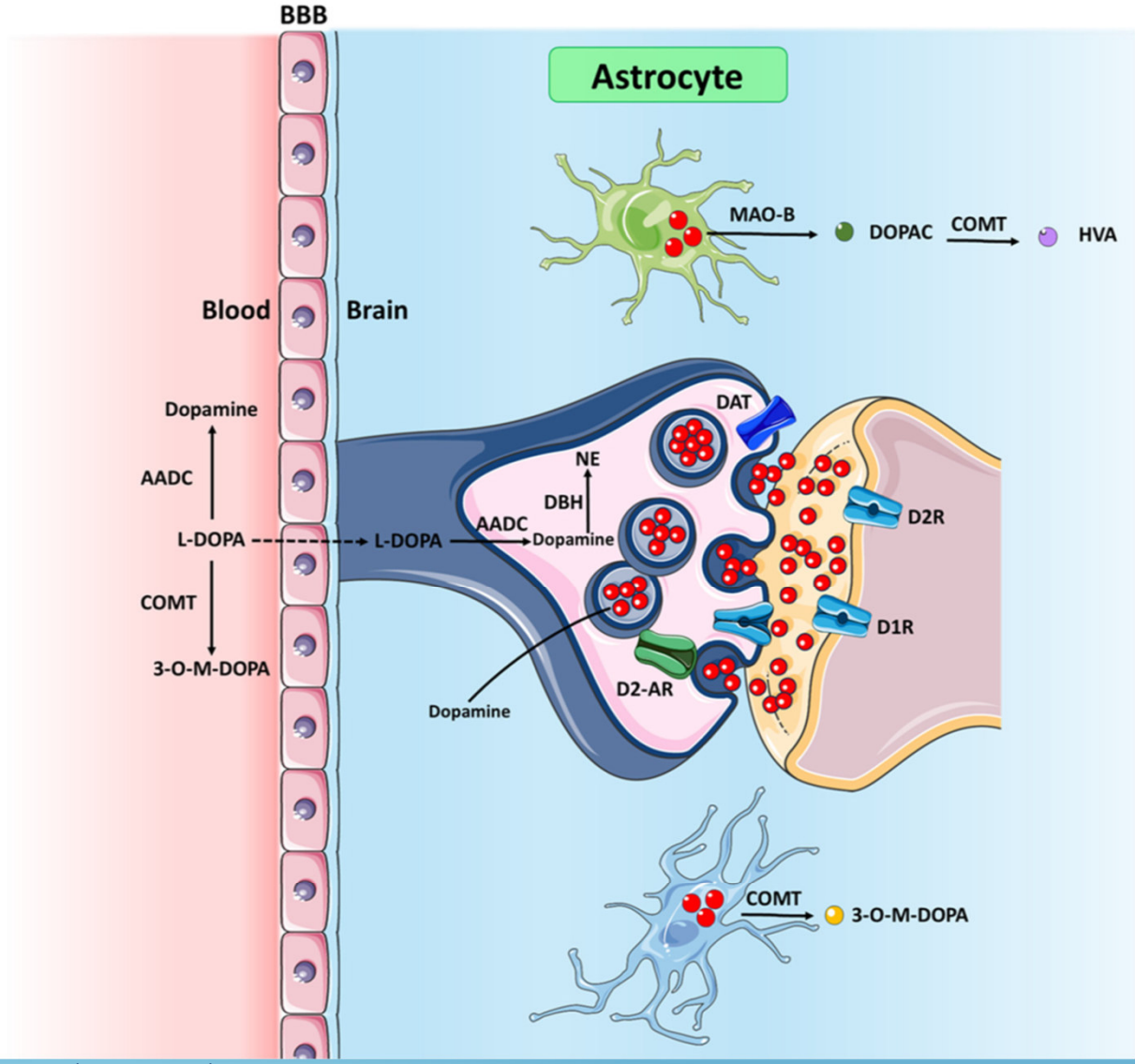
STABLE PD



FLUCTUATIG PD





Ursino M, et al. PloS one, 15(3), e0229729 (2020).

di Biase L., et al. (2021). Expert Review of Neurotherapeutics, DOI: 10.1080/14737175.2021.2000392

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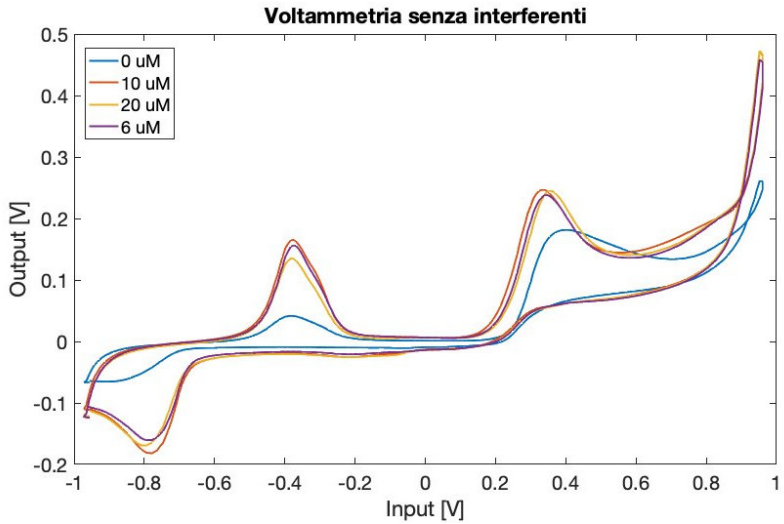
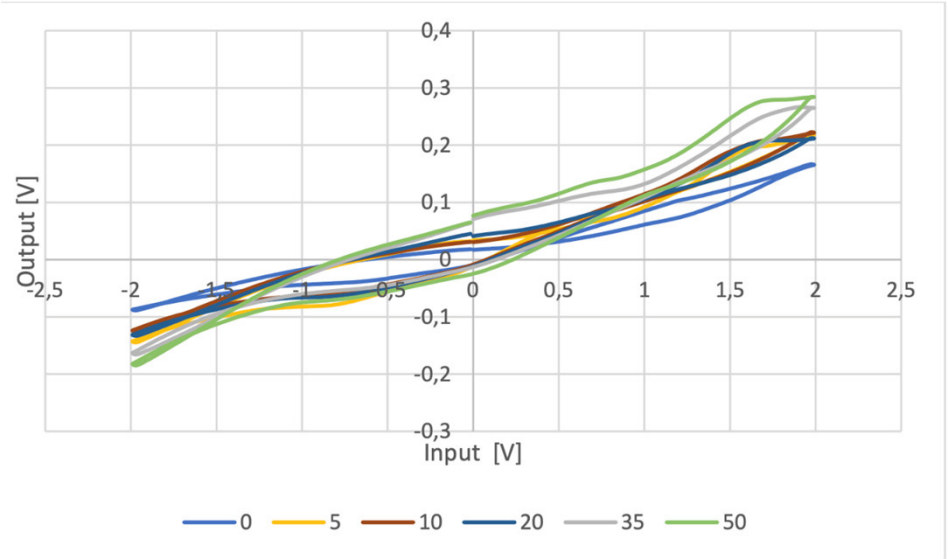
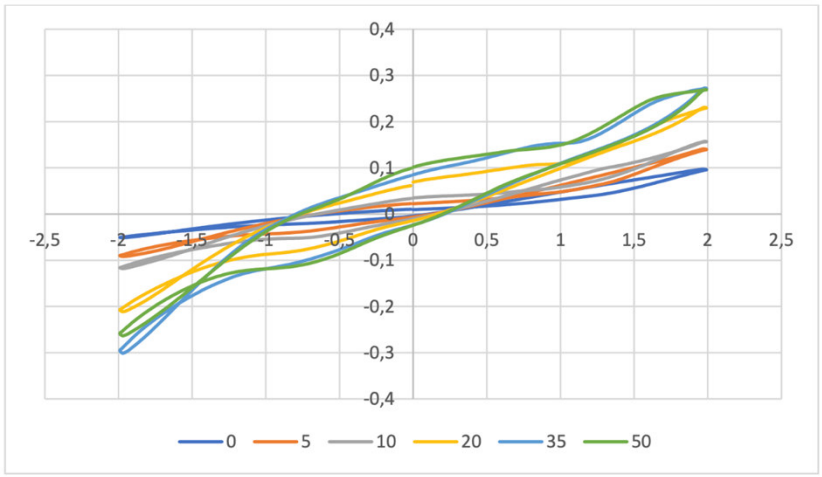
L-DOPA: 0,6,10,20 µM
Prediction Model → **6.93 µM**



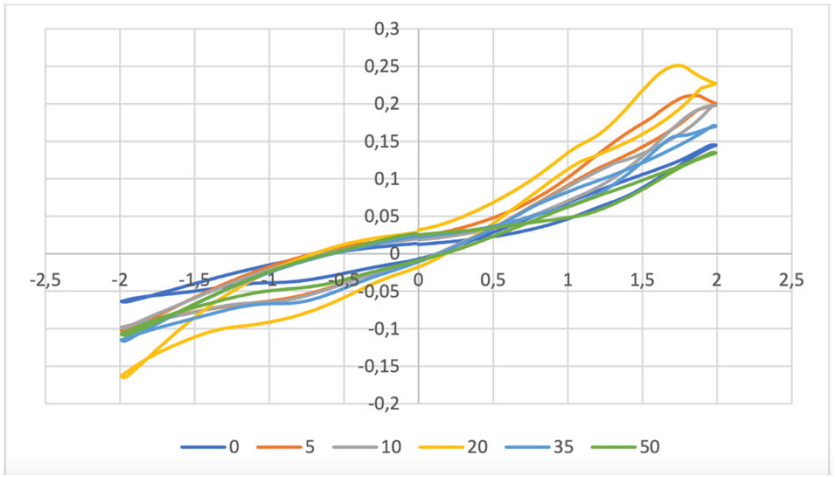
DOPAC: 0,5,10,20,35,50 µM
Prediction Model → **1.93 µM**



3-MethoxyTyramine (3MT): 0,5,10,20,35,50 µM
Prediction Model → **2.84 µM**



3-O-Methyldopa (3-OMD): 0,5,10,20,35,50 µM
Prediction Model → **5.37 µM**

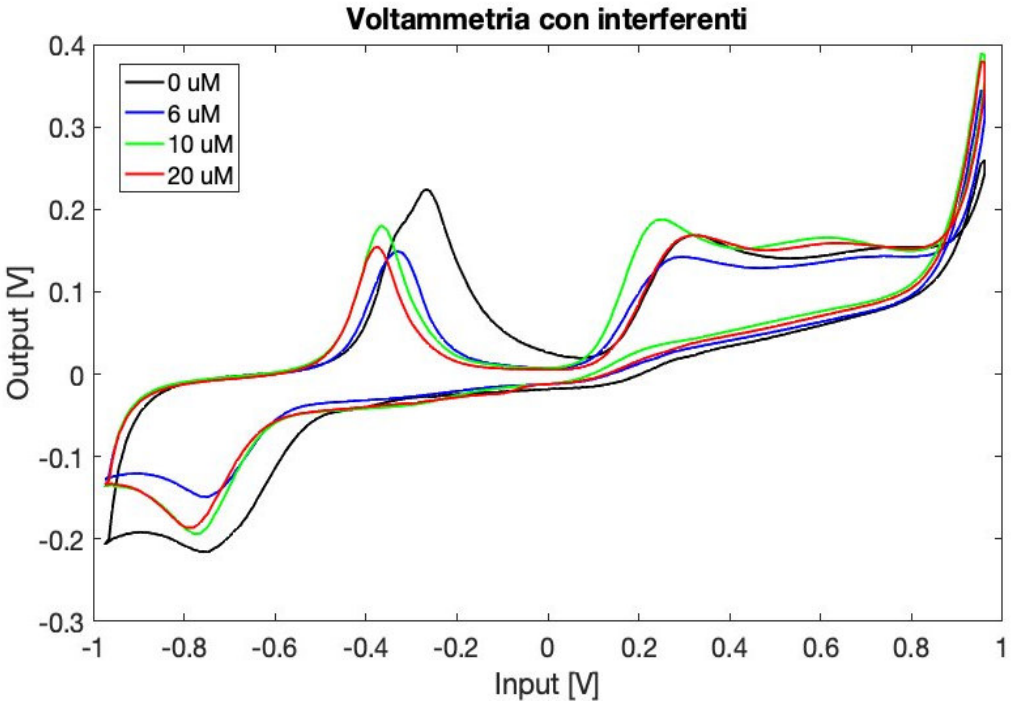


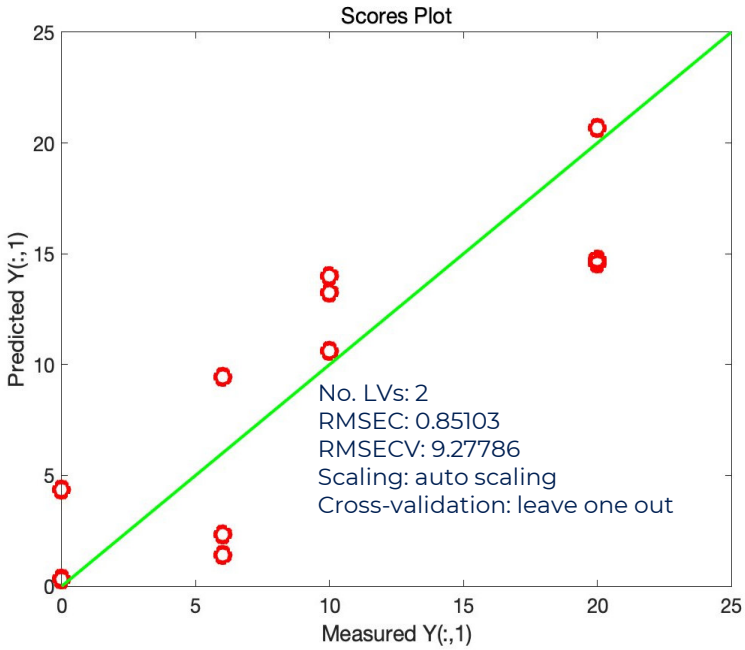
L-DOPA: 0,6,10,20 µM

with the presence of **interferents** :

- **Lactic acid (20 mM)**
- **Ascorbic acid (50 µM)**
- **Urea (10 mM).**

Prediction Model → **9.27 µM**





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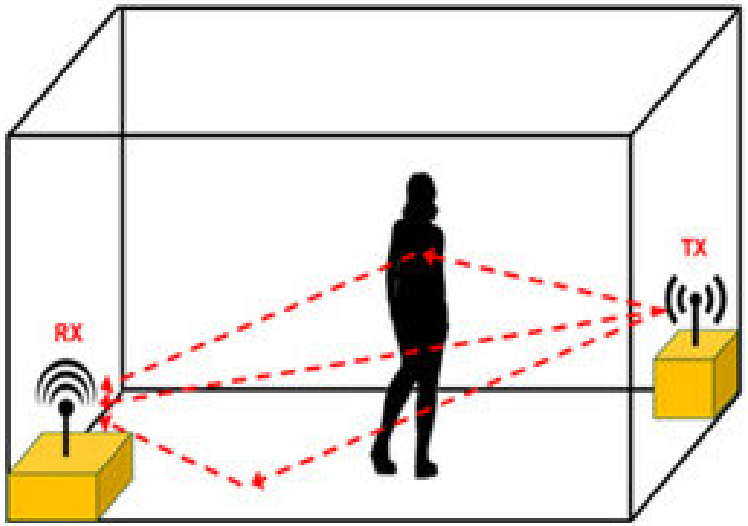
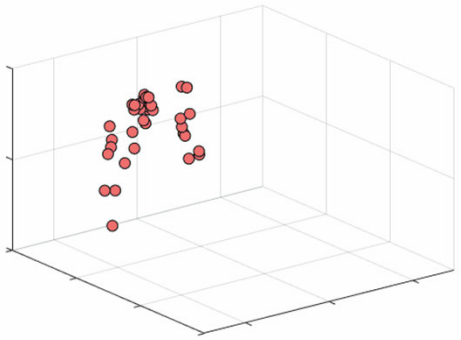
IR MONITORING

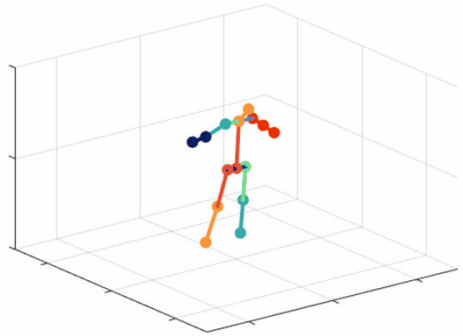
Radar



Radar Point Cloud:



Radar Estimation:



di Biase, L., et al. (2022). Markerless Radio Frequency Indoor Monitoring for Telemedicine: Gait Analysis, Indoor Positioning, Fall Detection, Tremor Analysis, Vital Signs and Sleep Monitoring. *Sensors*, *22*(21), 8486. https://doi.org/10.3390/s22218486

An, S., Li, Y., & Ogras, U. (2022). mri: Multi-modal 3d human pose estimation dataset using mmwave, rgb-d, and inertial sensors. Advances in neural information processing systems, 35, 27414-27426.

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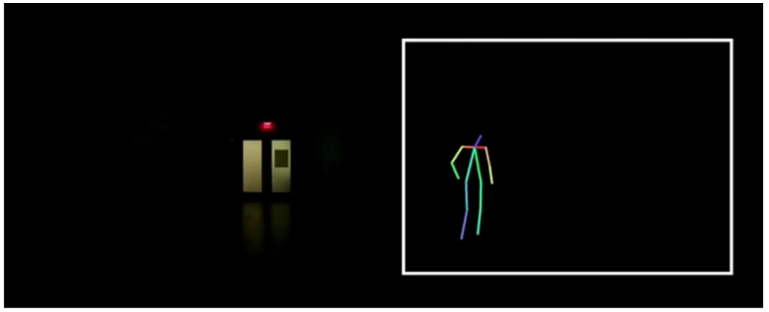
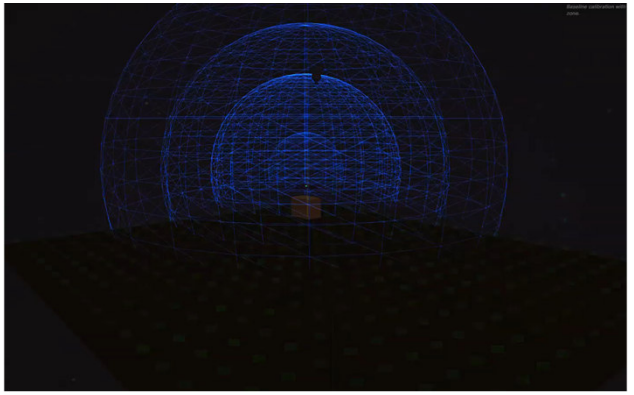
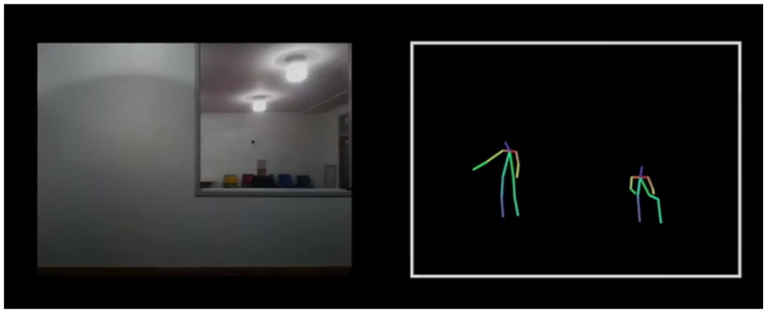
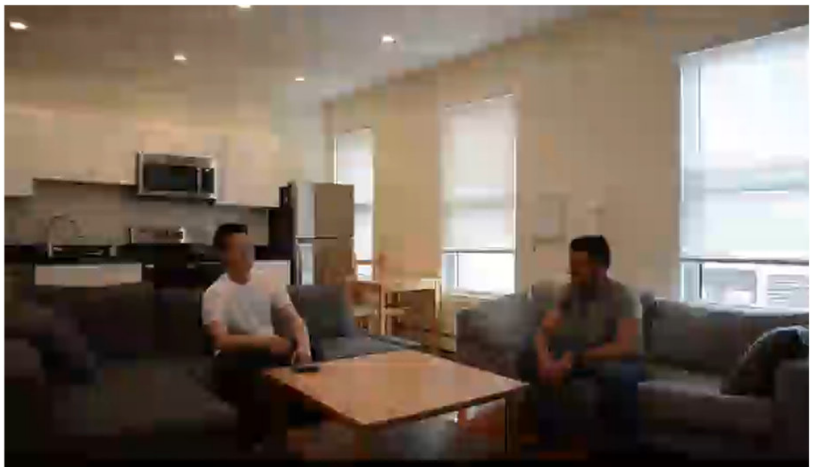


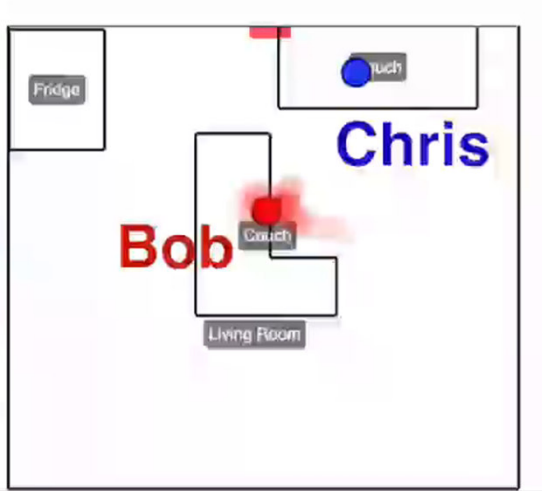


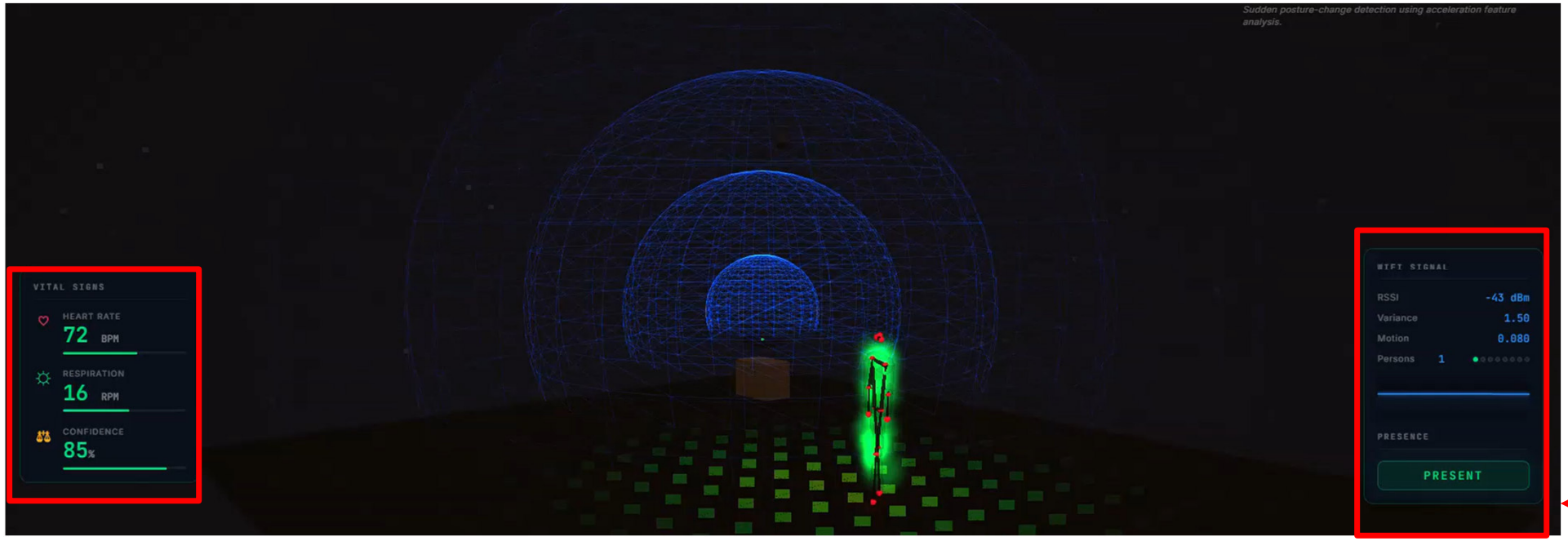

Radar

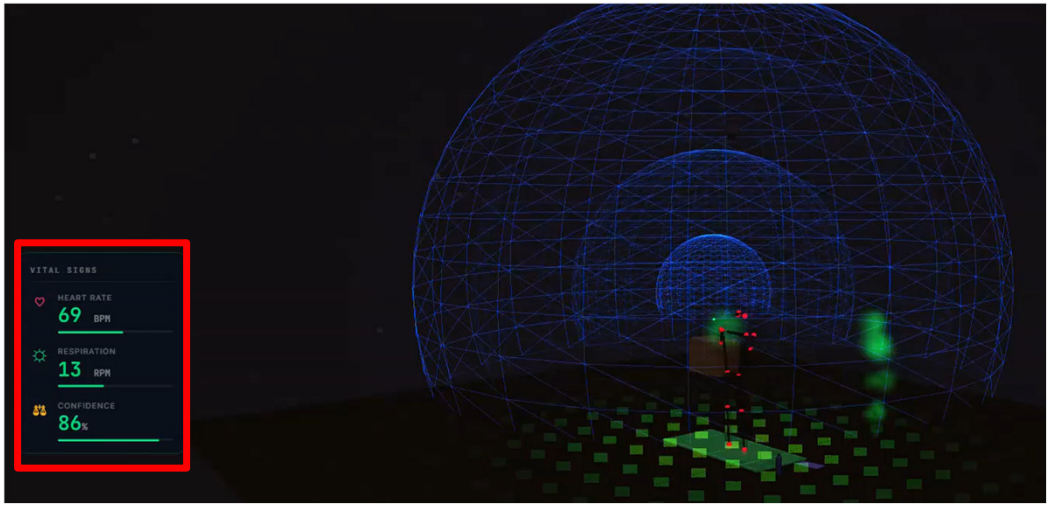


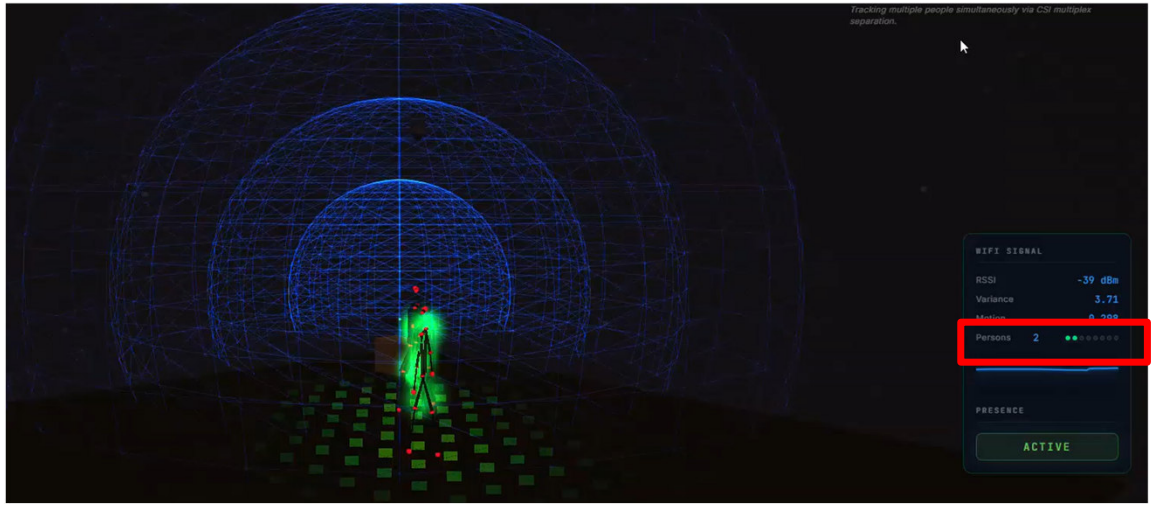

Velocity

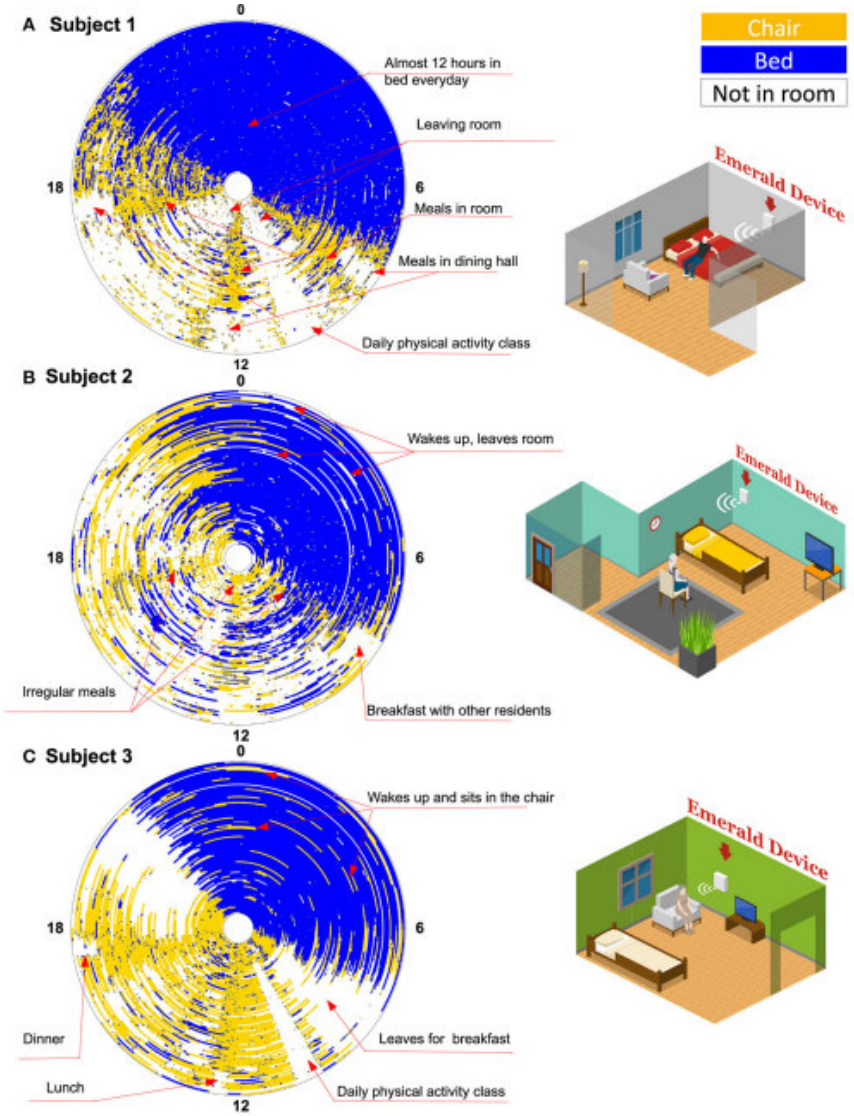



Fridge
Chris
Bob
Couch
Living Room

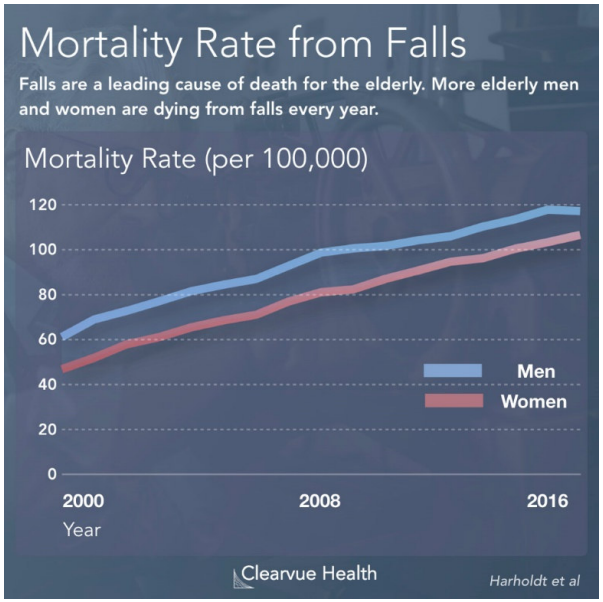

Sudden posture-change detection using acceleration feature analysis.
VITAL SIGNS
HEART RATE
72 BPM
RESPIRATION
16 RPM
CONFIDENCE
85%
WIFI SIGNAL
RSSI -43 dBm
Variance 1.50
Motion 0.080
Persons 1
PRESENCE
PRESENT

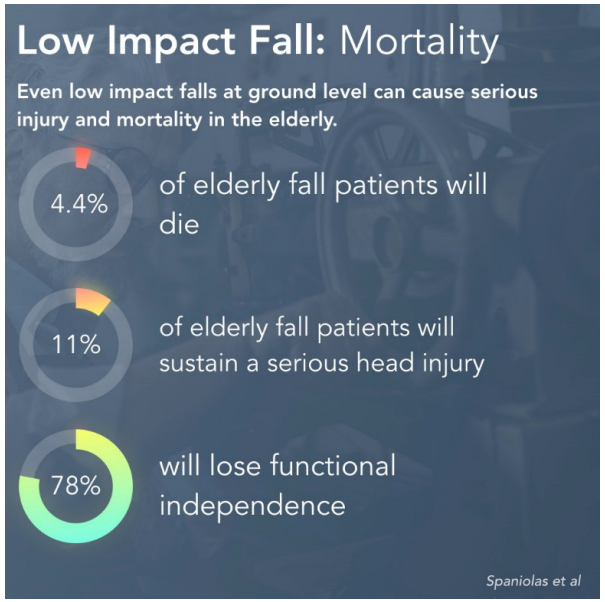

VITAL SIGNS
HEART RATE
69 BPM
RESPIRATION
13 RPM
CONFIDENCE
86%

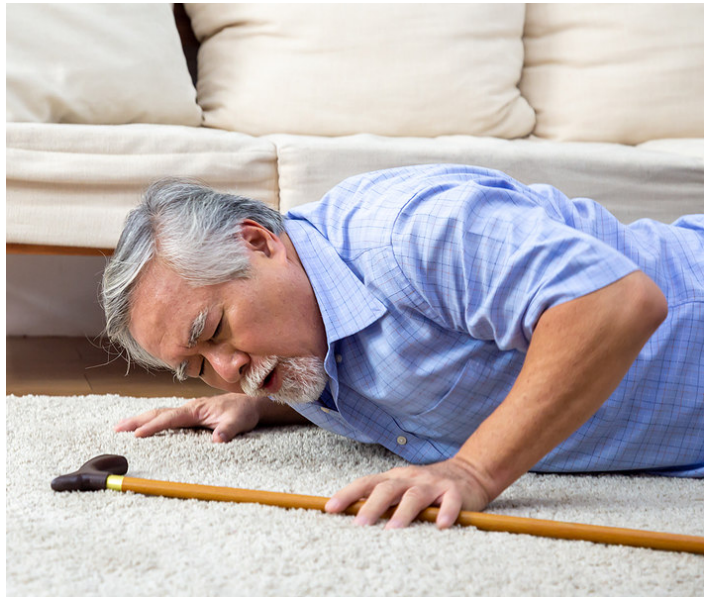

Tracking multiple people simultaneously via CSI multiplex separation.
WIFI SIGNAL
RSSI -39 dBm
Variance 3.71
Persons 2
PRESENCE
ACTIVE

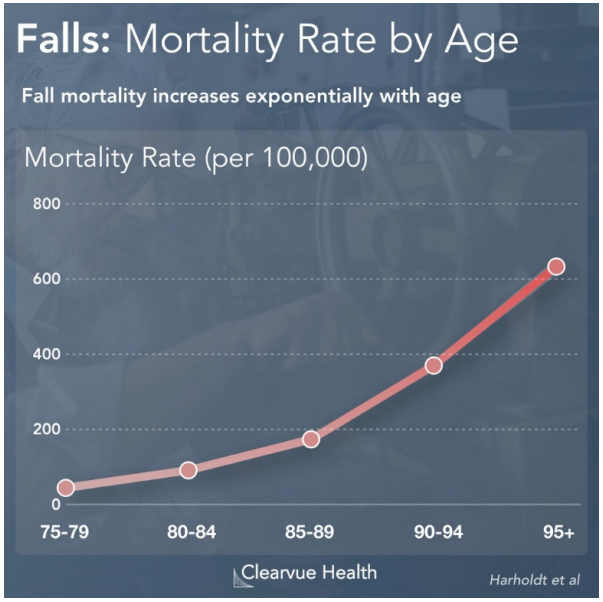


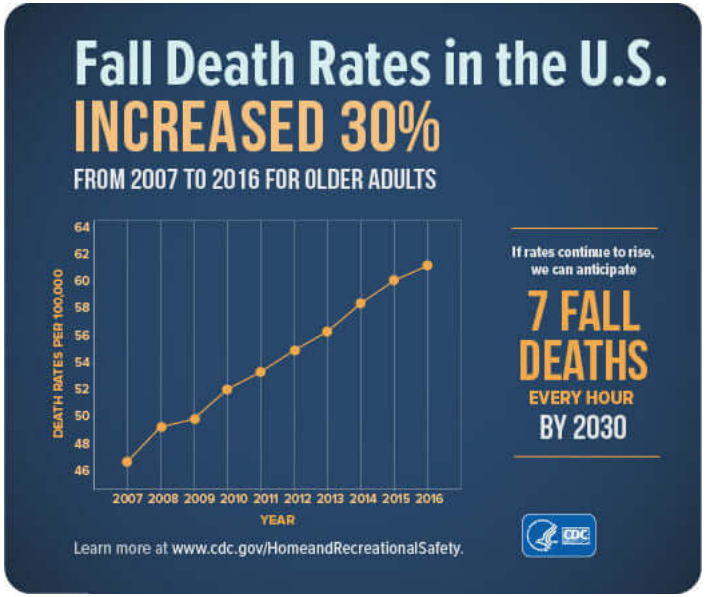
Zhang, G., et al., *Contactless In-Home Monitoring of the Long-Term Respiratory and Behavioral Phenotypes in Older Adults With COVID-19: A Case Series.* Front Psychiatry, 2021. **12**: p. 754169.

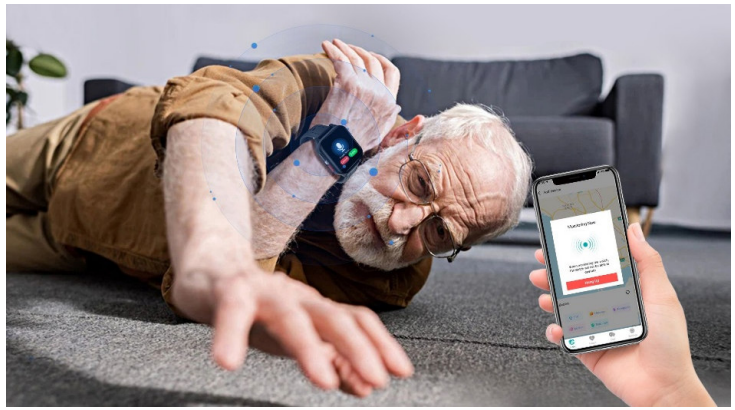

Mortality Rate from Falls
Falls are a leading cause of death for the elderly. More elderly men and women are dying from falls every year.
Mortality Rate (per 100,000)
120
100
80
60
40
20
0
Men
Women
2000
2008
2016
Year
Clearvue Health
Harholdt et al


Low Impact Fall: Mortality
Even low impact falls at ground level can cause serious injury and mortality in the elderly.
4.4%
of elderly fall patients will die
11%
of elderly fall patients will sustain a serious head injury
78%
will lose functional independence
Spaniolas et al

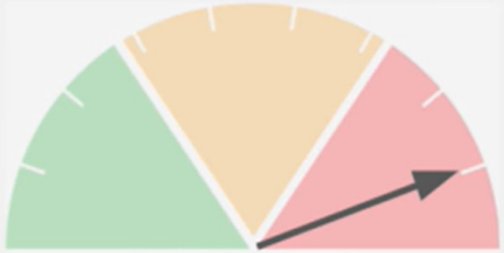



Falls: Mortality Rate by Age
Fall mortality increases exponentially with age
Mortality Rate (per 100,000)
800
600
400
200
0
75-79
80-84
85-89
90-94
95+
Clearvue Health
Harholdt et al


Fall Death Rates in the U.S.
INCREASED 30%
FROM 2007 TO 2016 FOR OLDER ADULTS
DEATH RATES PER 100,000
64
62
60
58
56
54
52
50
48
46
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
YEAR
If rates continue to rise, we can anticipate
7 FALL DEATHS
EVERY HOUR
BY 2030
Learn more at www.cdc.gov/HomeandRecreationalSafety.



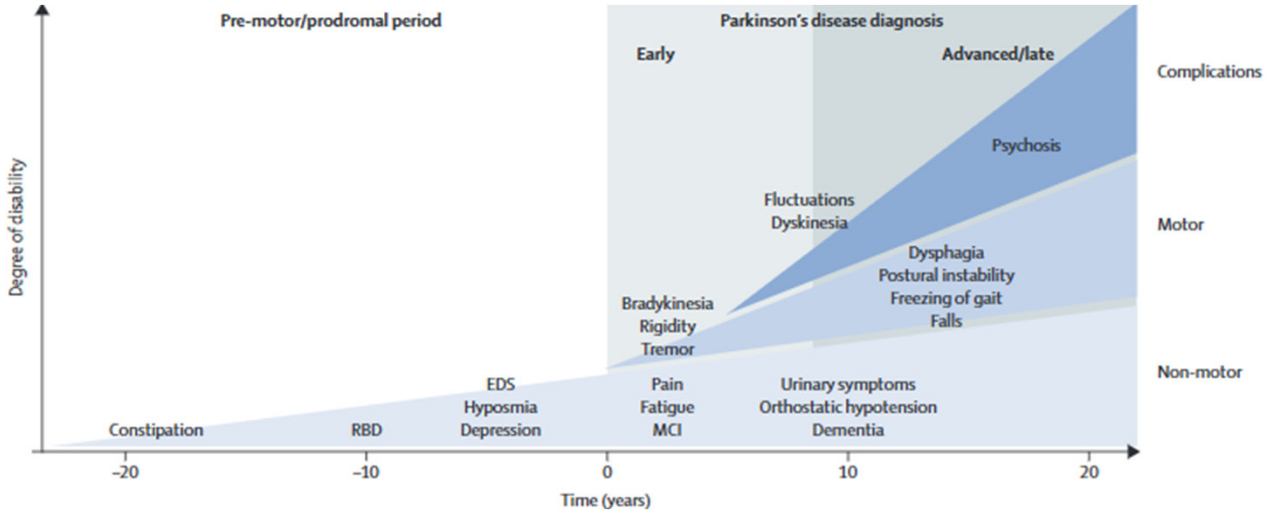
Name : James Smith
PN : 07865467



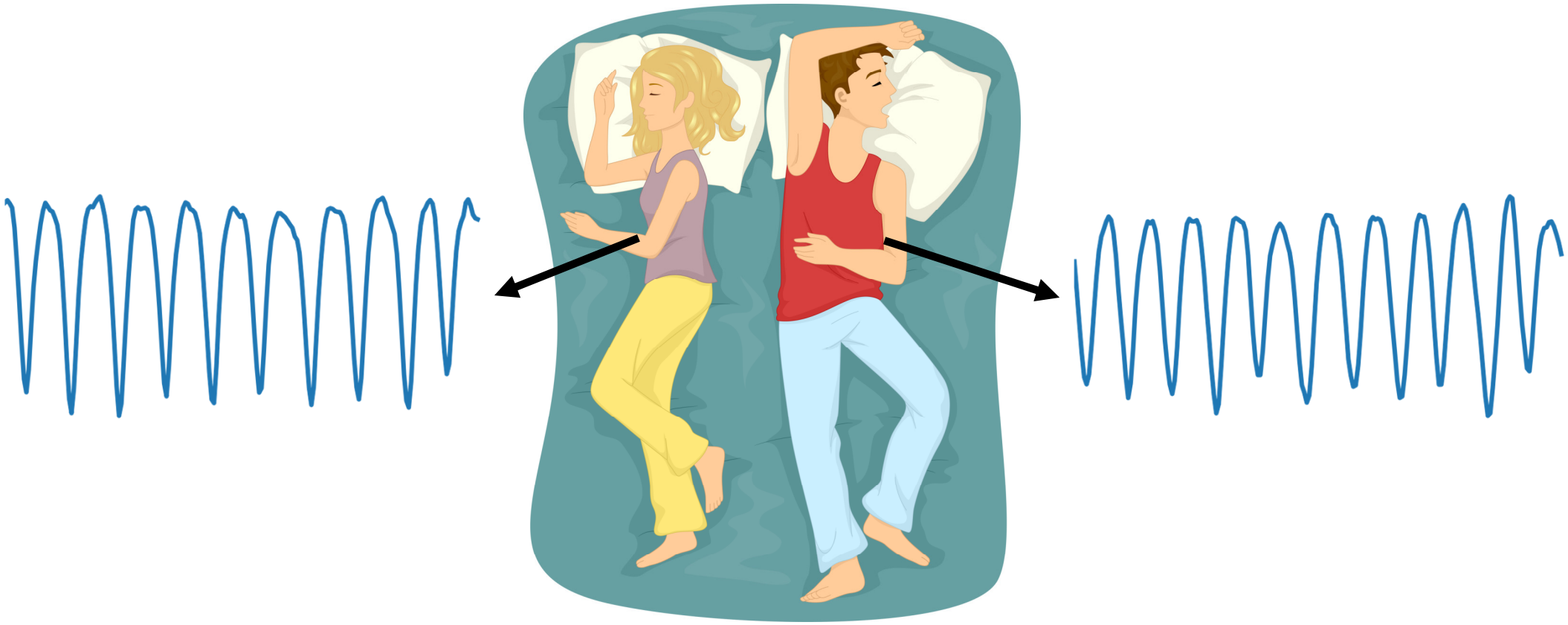
[redacted]

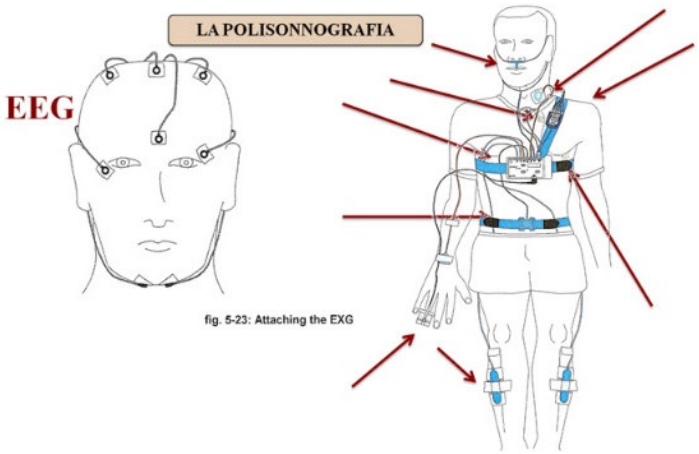
[redacted]

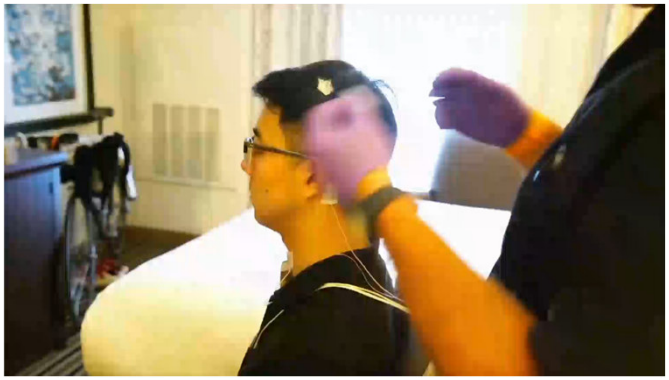
SLEEP MONITORING

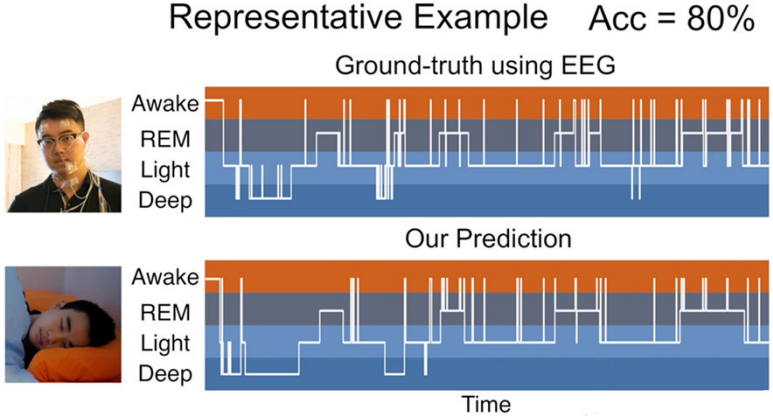


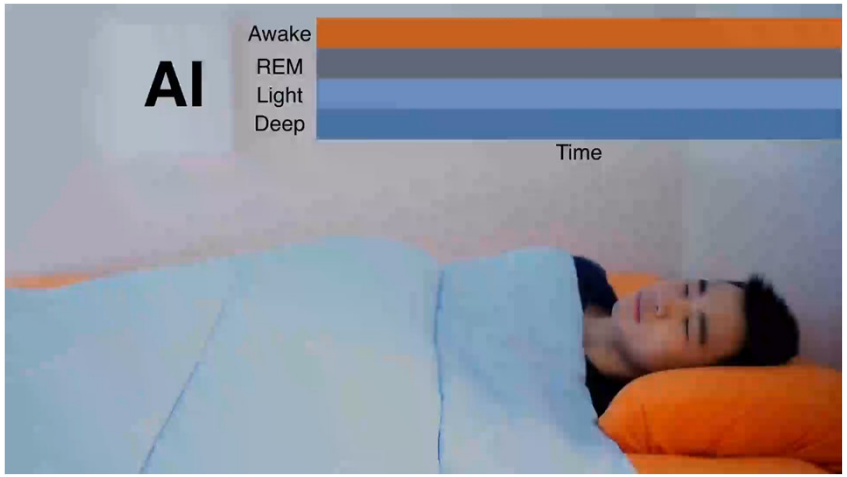
Non-Contact Sleep Analysis

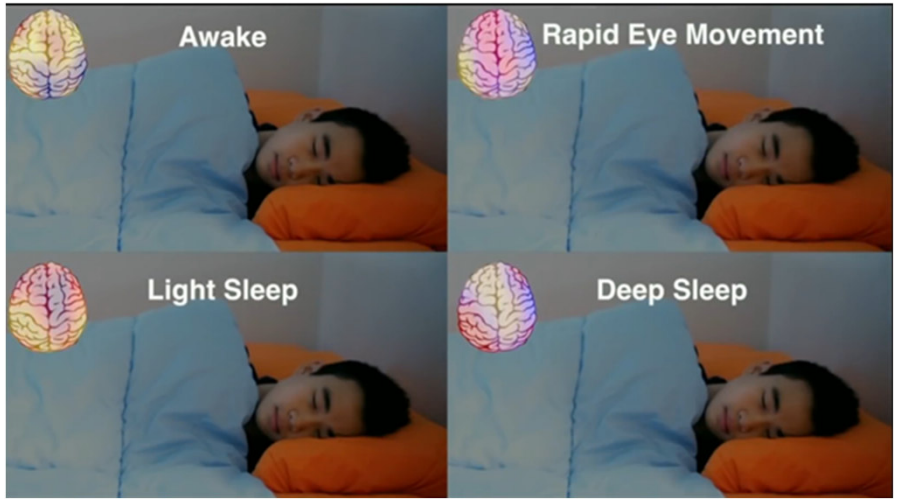



LA POLISONNOGRAFIA
EEG
fig. 5-23: Attaching the EXG




Representative Example
Acc = 80%
Ground-truth using EEG
Awake
REM
Light
Deep
Our Prediction
Awake
REM
Light
Deep
Time


AI
Awake
REM
Light
Deep
Time


Awake
Rapid Eye Movement
Light Sleep
Deep Sleep

nature medicine

ARTICLES

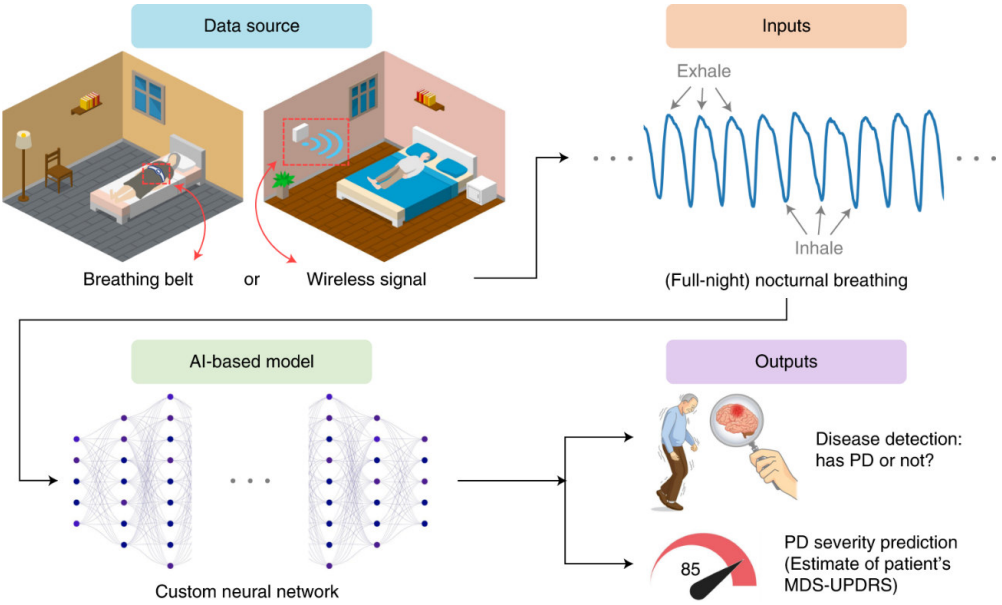
https://doi.org/10.1038/s41591-022-01932-x

Check for updates

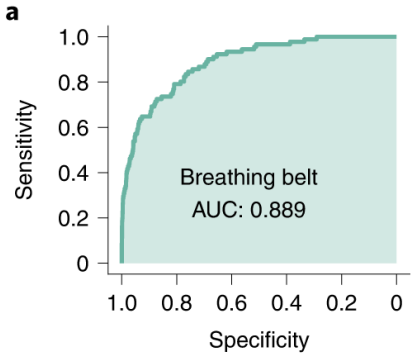
OPEN

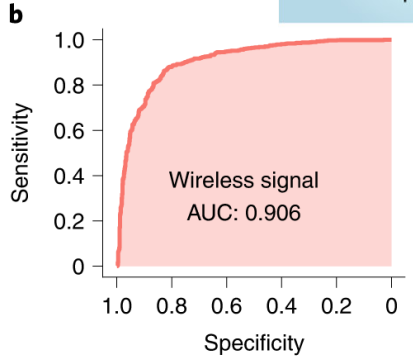
Artificial intelligence-enabled detection and assessment of Parkinson's disease using nocturnal breathing signals

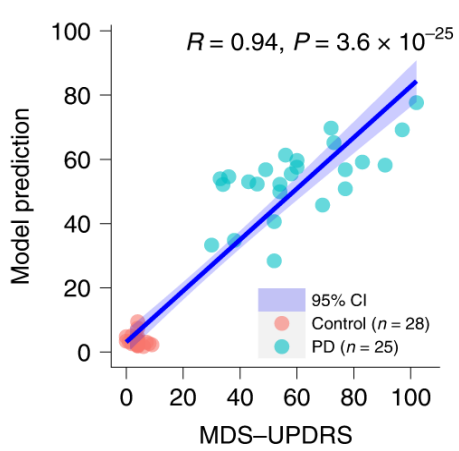
Yuzhe Yang[1✉], Yuan Yuan[1✉], Guo Zhang[1], Hao Wang[1,2], Ying-Cong Chen[1], Yingcheng Liu[1], Christopher G. Tarolli[3,4], Daniel Crepeau[5], Jan Bukartyk[6], Mithri R. Junna[7], Aleksandar Videnovic[8], Terry D. Ellis[9], Melissa C. Lipford[7], Ray Dorsey[3,4] and Dina Katabi[1,10]

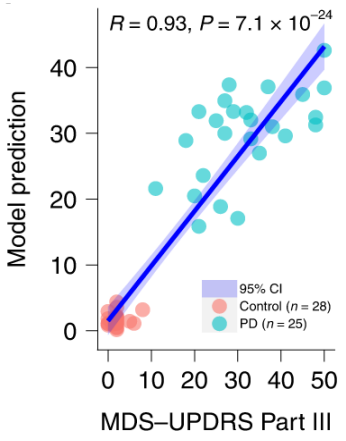


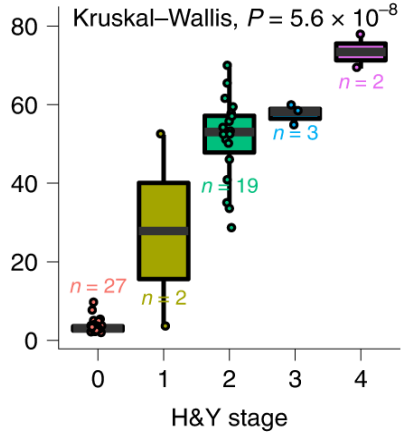
Radar











Yang, Y., et al (2022). Artificial intelligence-enabled detection and assessment of Parkinson's disease using nocturnal breathing signals. Nature Medicine, 28(10), 2207–2215. https://doi.org/10.1038/s41591-022-01932-x

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Brain Computer Interfaces

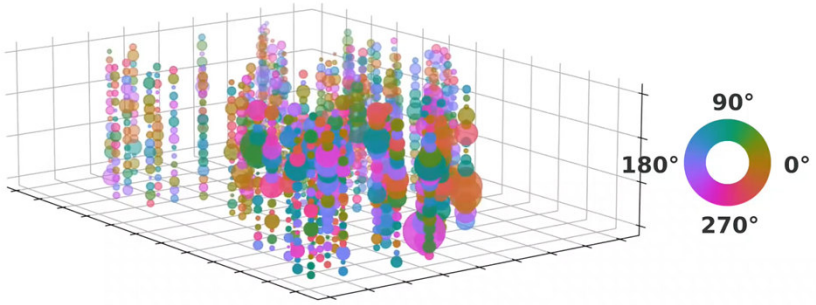
BCI Motor Cortex - Neuralink

LINK

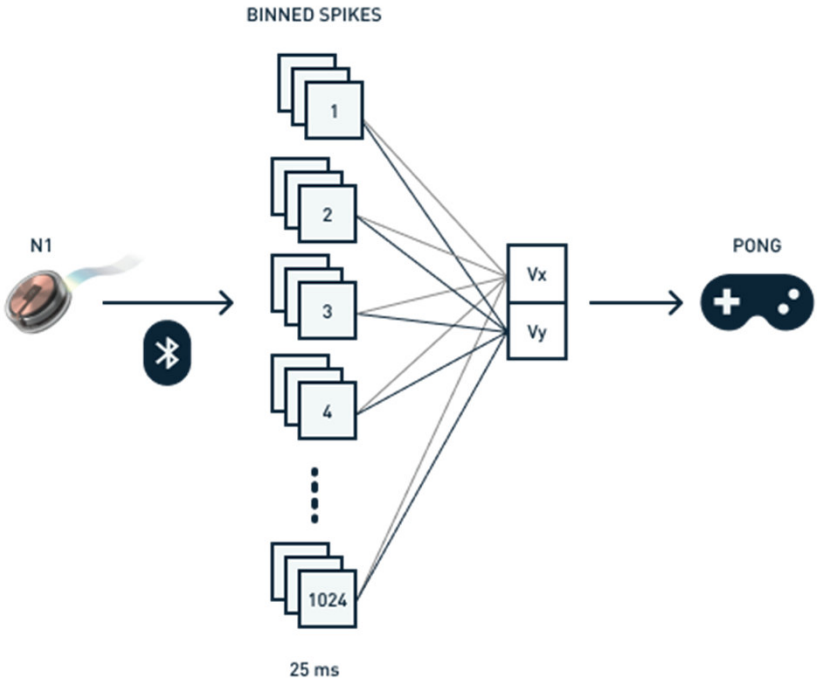
Sealed, implanted devices that receive, process and transmit neural signals.

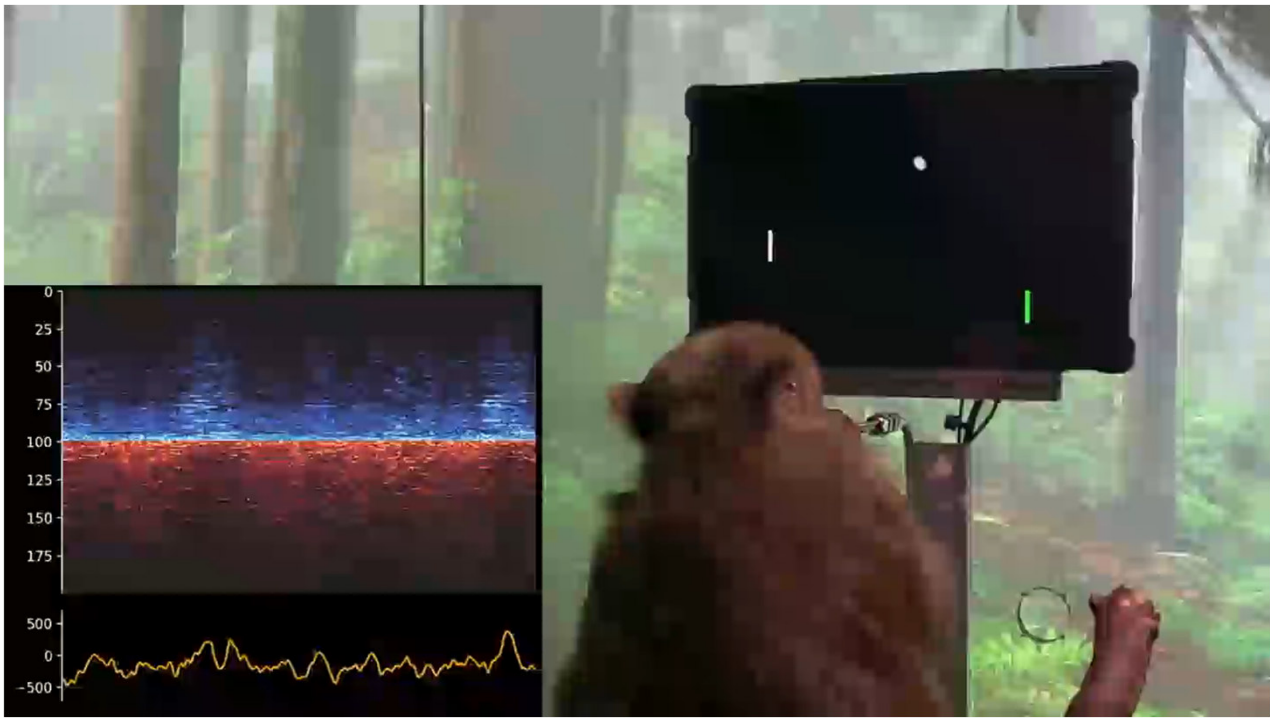
NEURAL THREADS

Each small and flexible thread contains many electrodes for detecting neural signals.

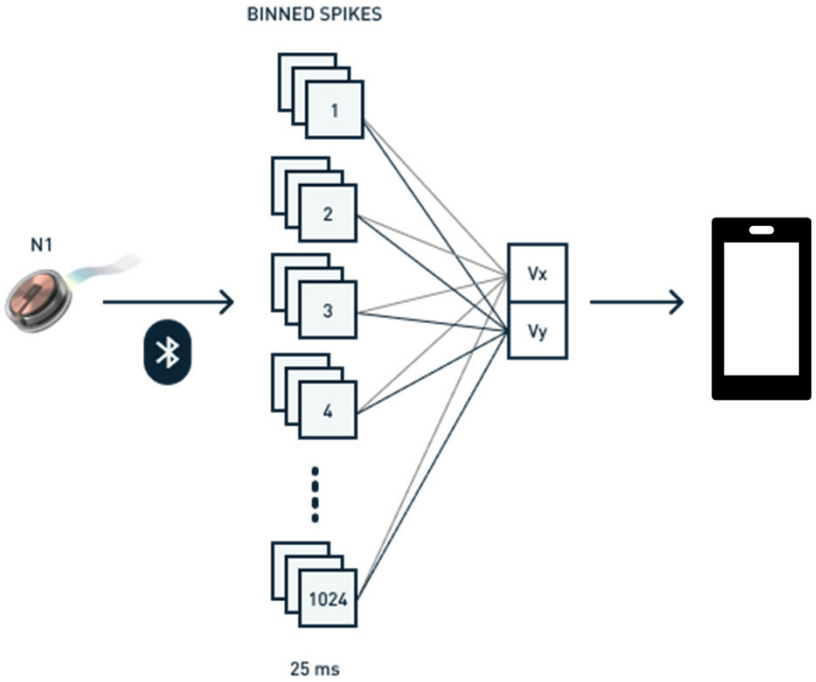


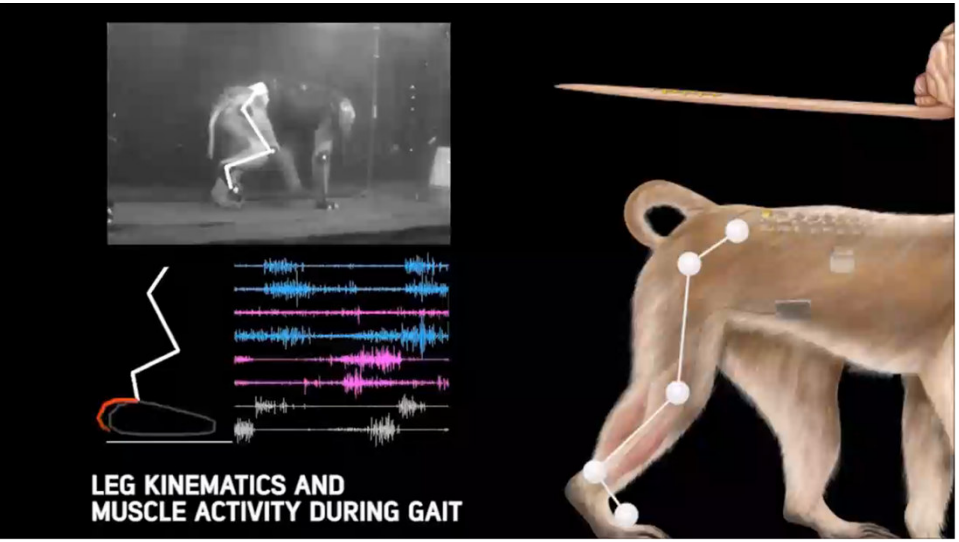
BCI Motor Cortex - Neuralink

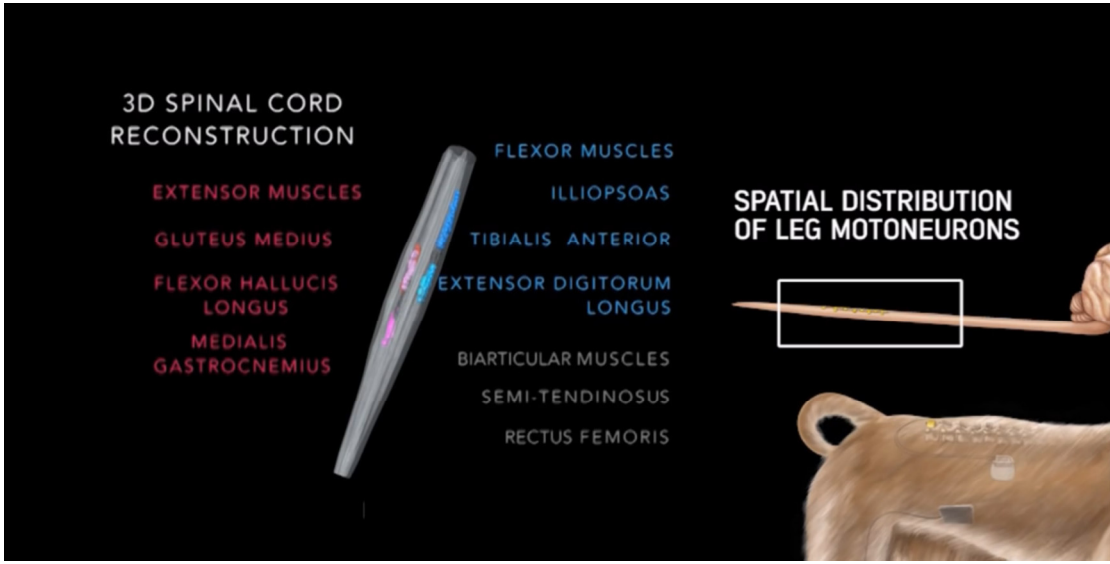




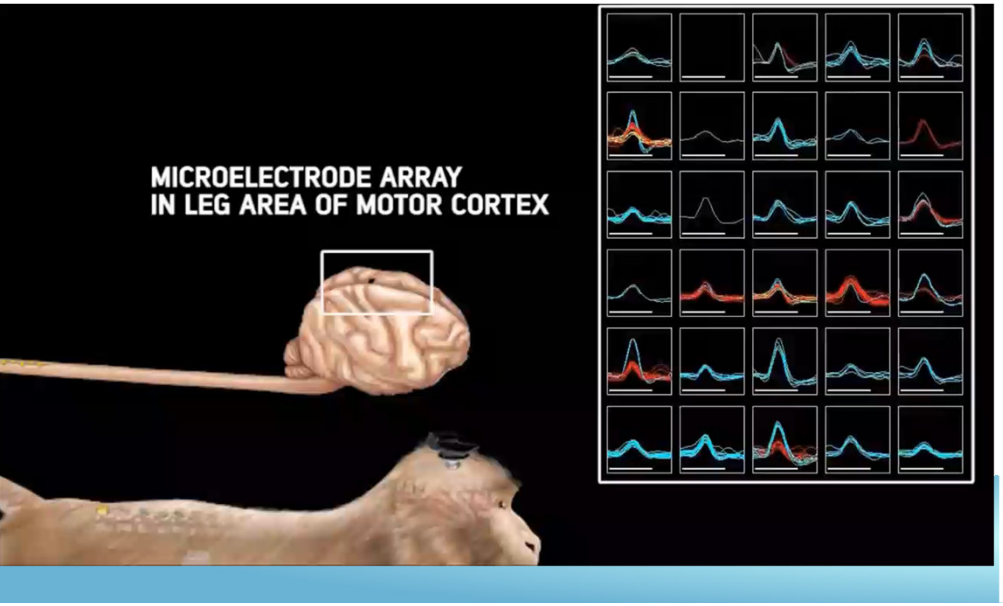
BCI Motor Cortex - Neuralink

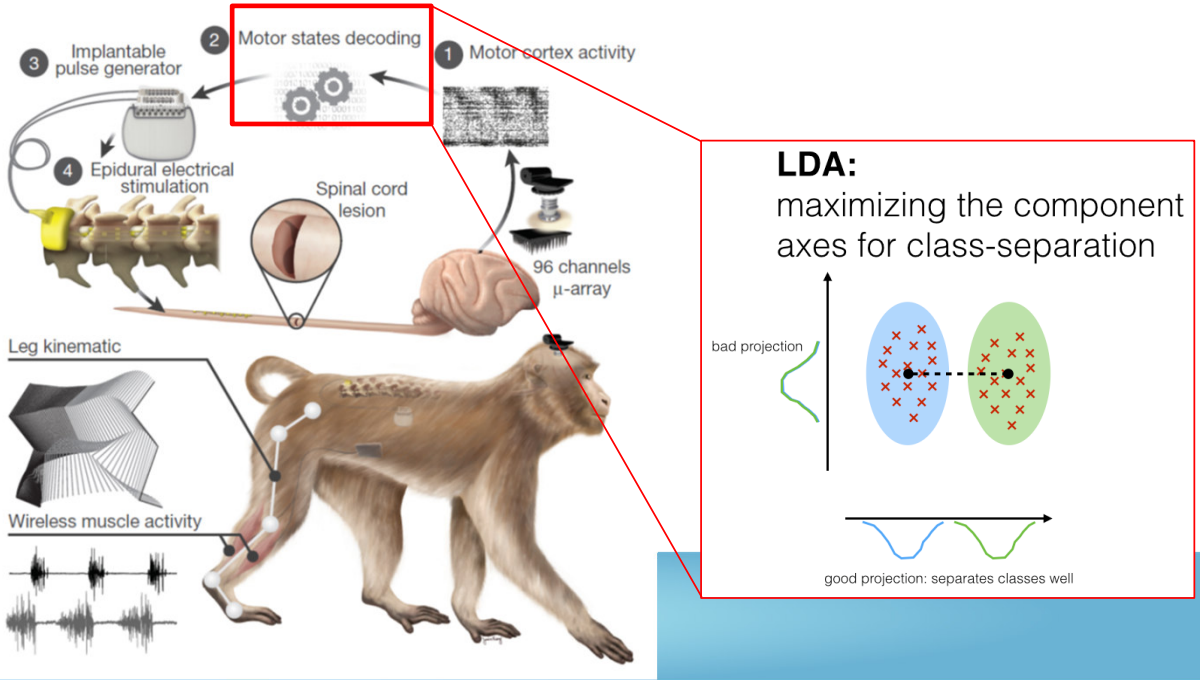




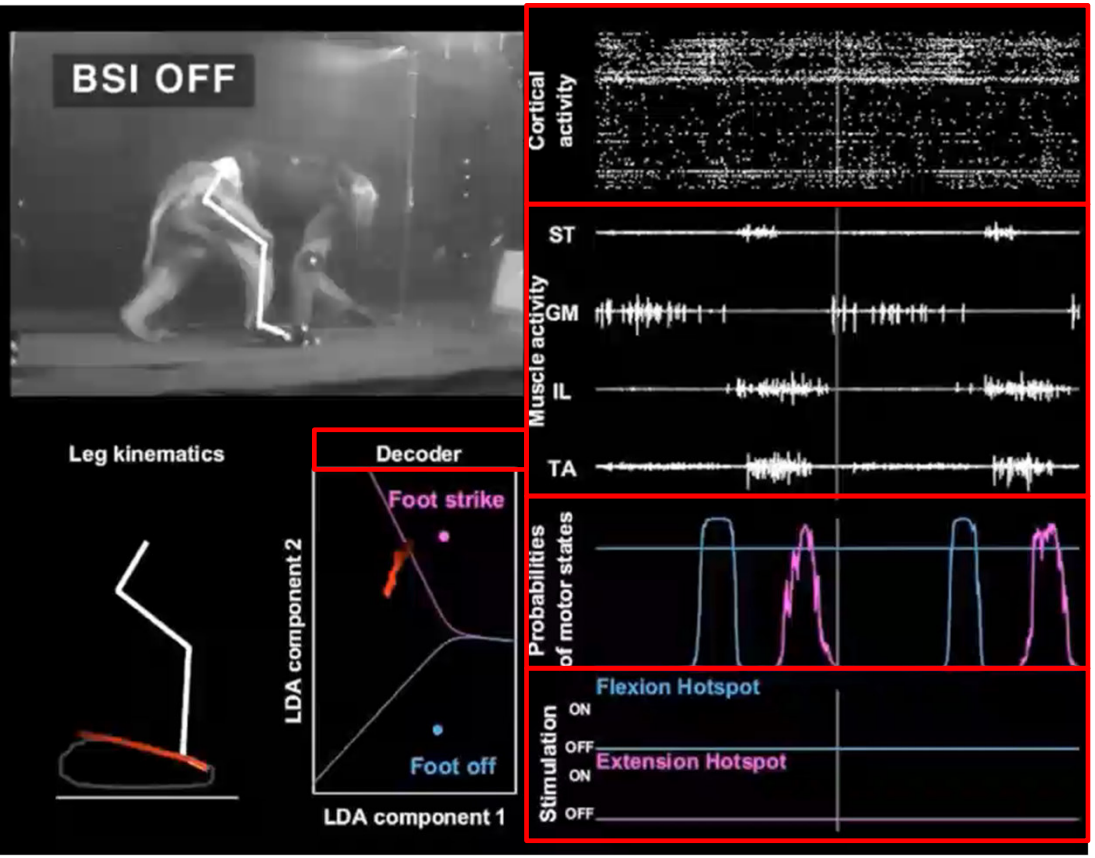


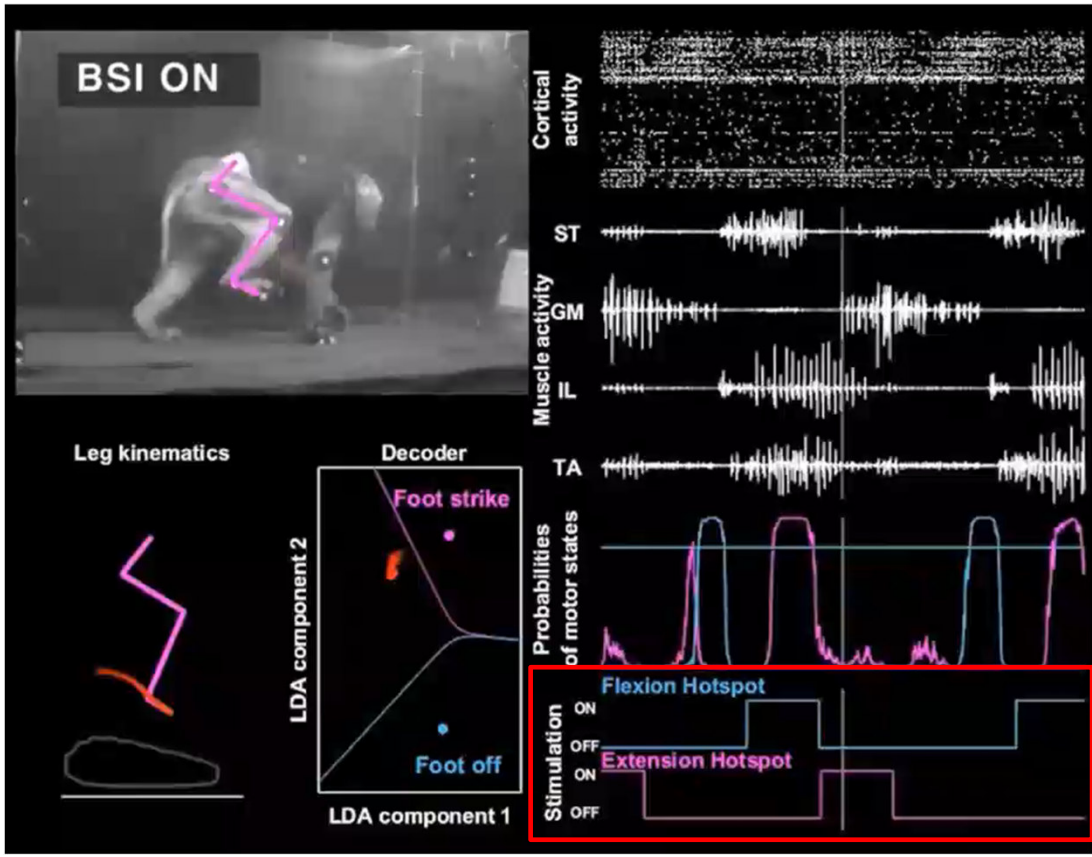
Capogrosso, M., et al. (2016).
Nature, *539*(7628), 284-288.





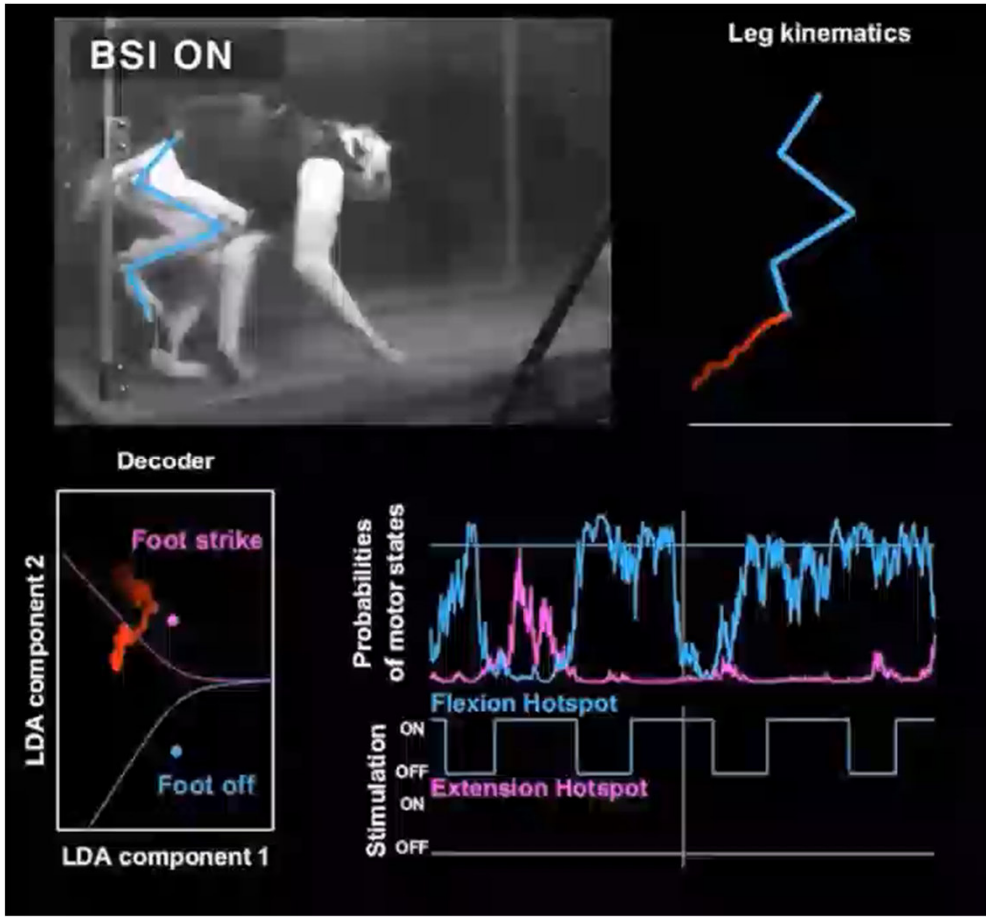
BRAIN-SPINE INTERFACE: INTACT MONKEY





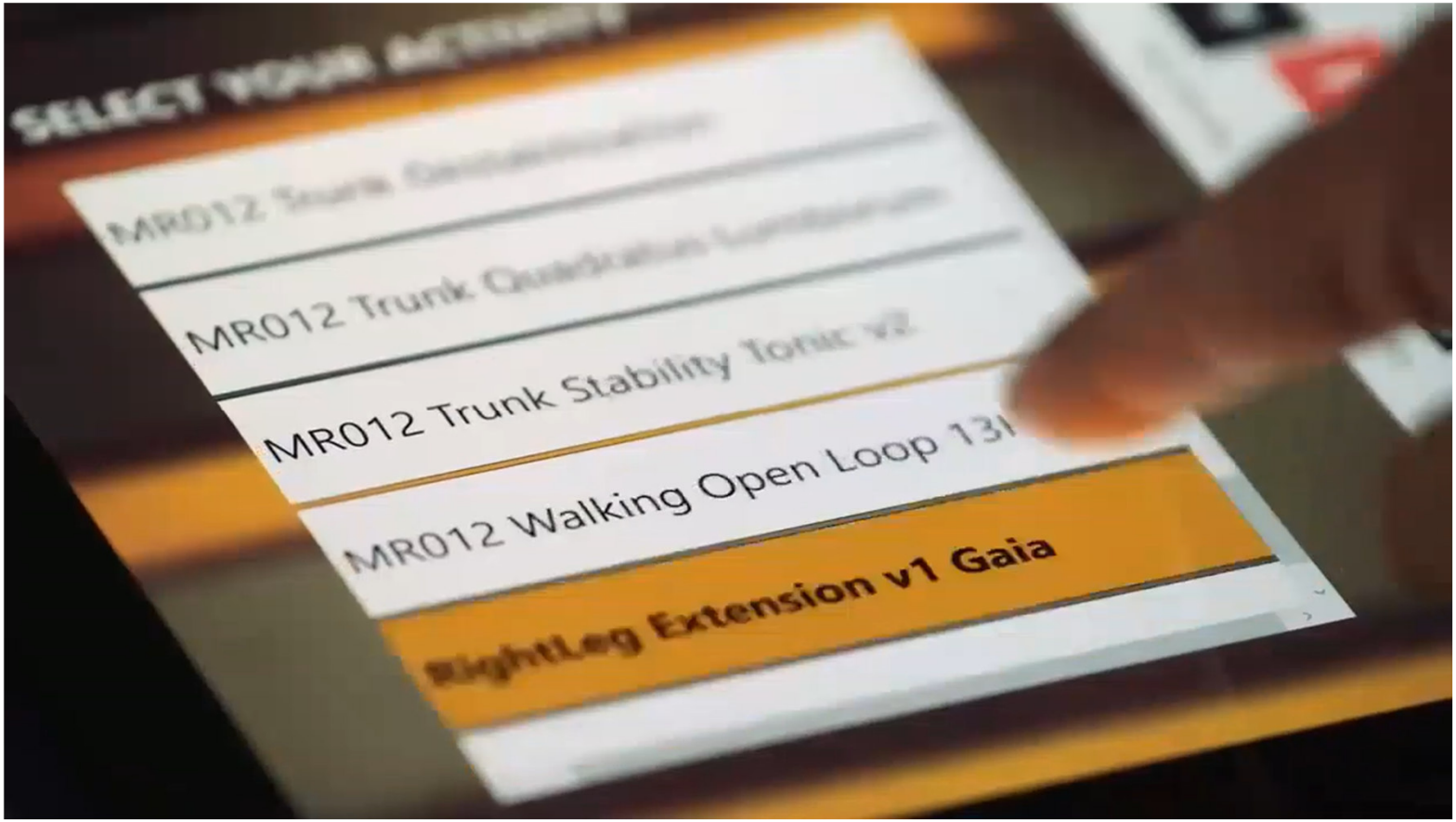
Capogrosso, M., et al. (2016). A brain–spine interface alleviating gait deficits after spinal cord injury in primates. *Nature*, *539*(7628), 284-288.

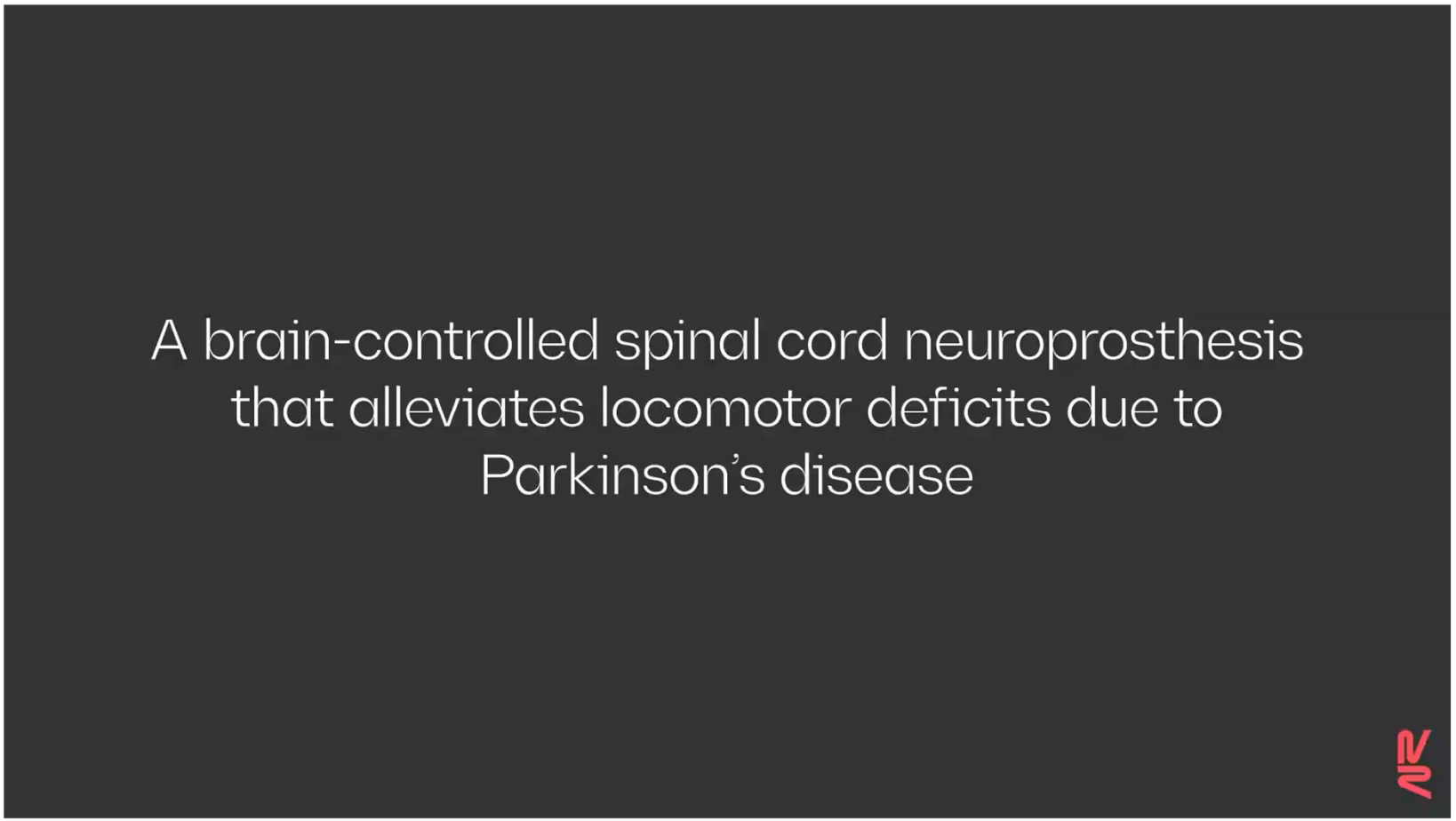
BRAIN-SPINE INTERFACE: POST SPINAL CORD LESION



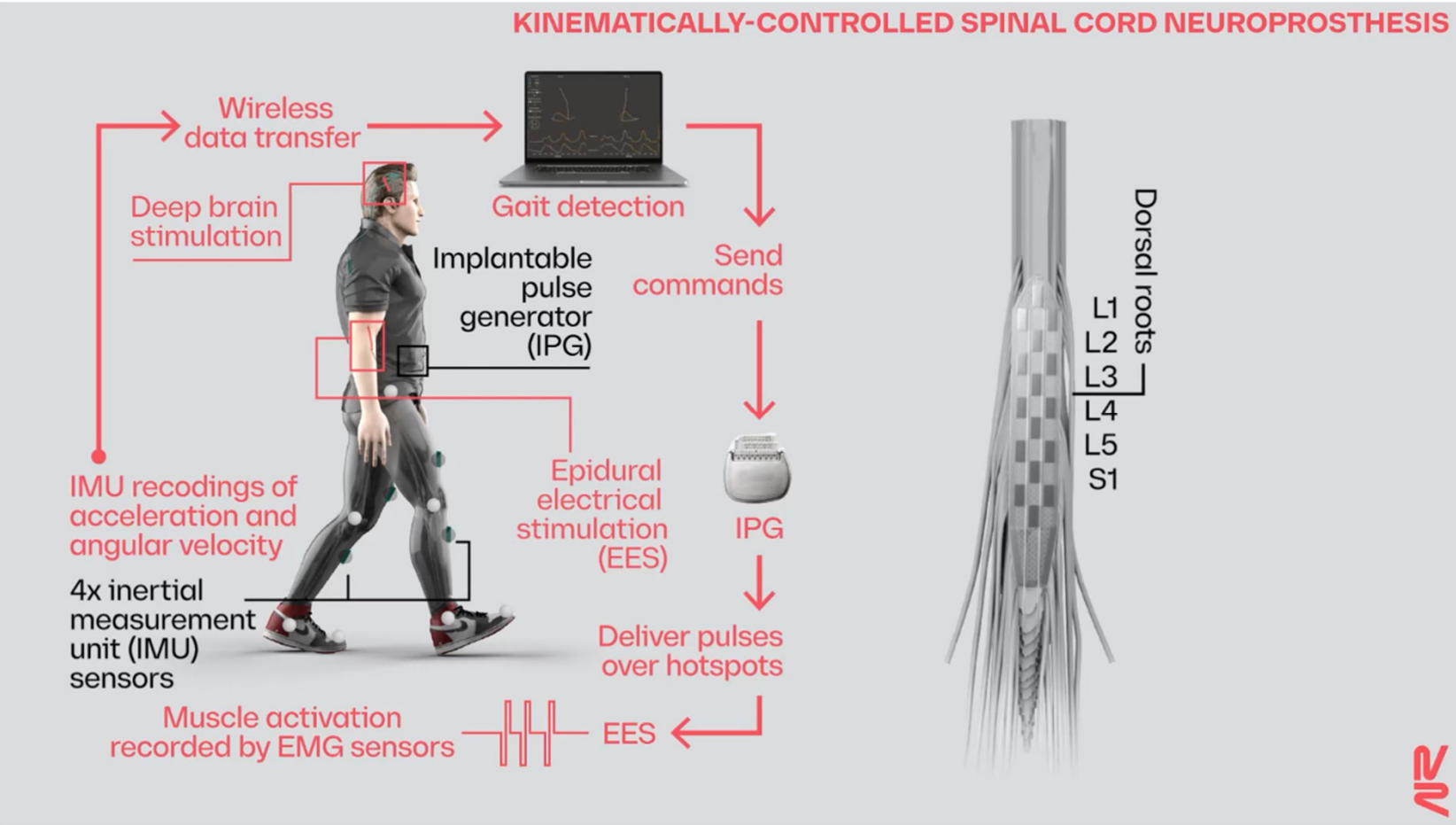
Capogrosso, M., et al. (2016). A brain–spine interface alleviating gait deficits after spinal cord injury in primates. *Nature*, *539*(7628), 284-288.


EPFL
Lausanne, Switzerland
how to correlate this brain signal
to the spinal cord stimulation.


SELECT YOUR ACTIVITY
MR012 Trunk Stability Tonic v2
MR012 Walking Open Loop 131
SightLeg Extension v1 Gaia

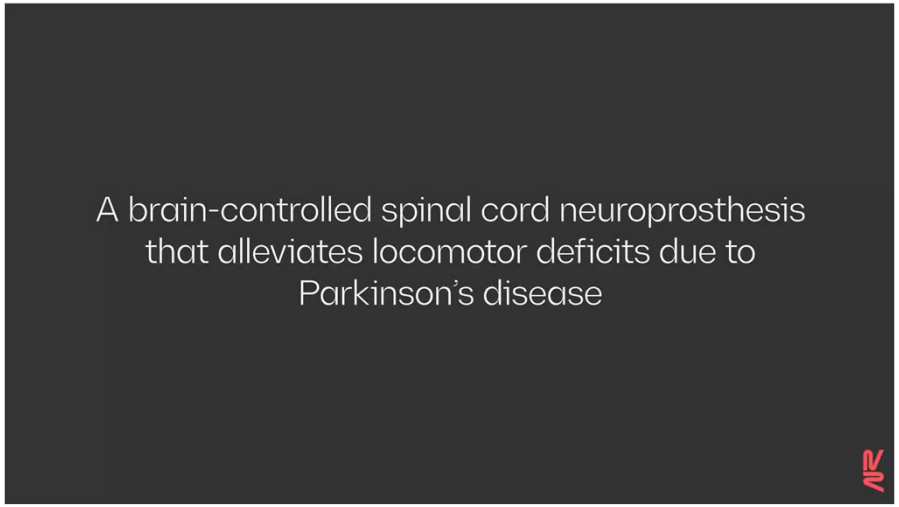


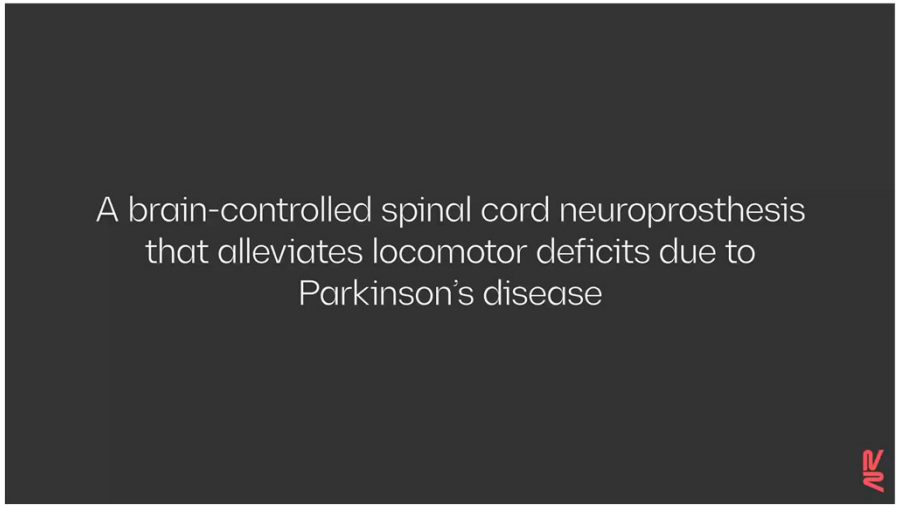
Milekovic, T., et al. *Nat Med* **29**, 2854–2865 (2023).
https://doi.org/10.1038/s41591-023-02584-1



Milekovic, T., et al. *Nat Med* **29**, 2854–2865 (2023).
https://doi.org/10.1038/s41591-023-02584-1

Spinal Cord Stimulation
OFF





Spinal Cord Stimulation
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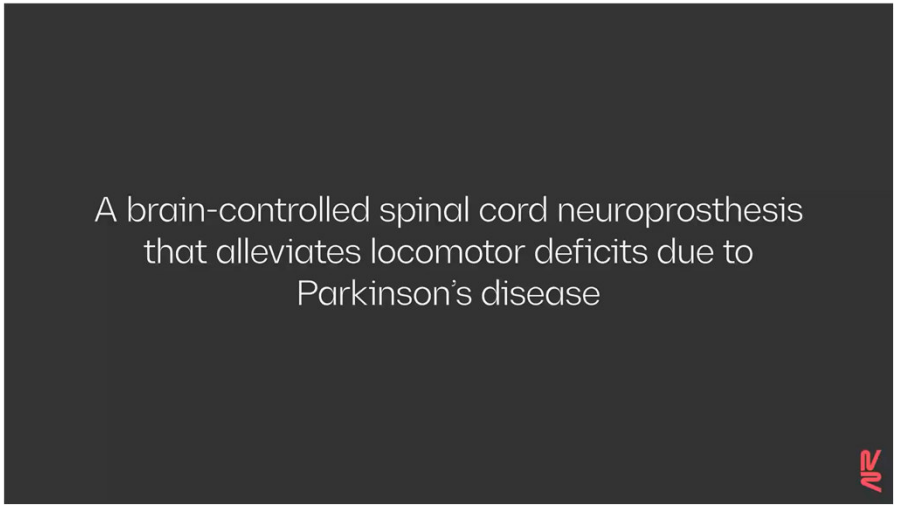

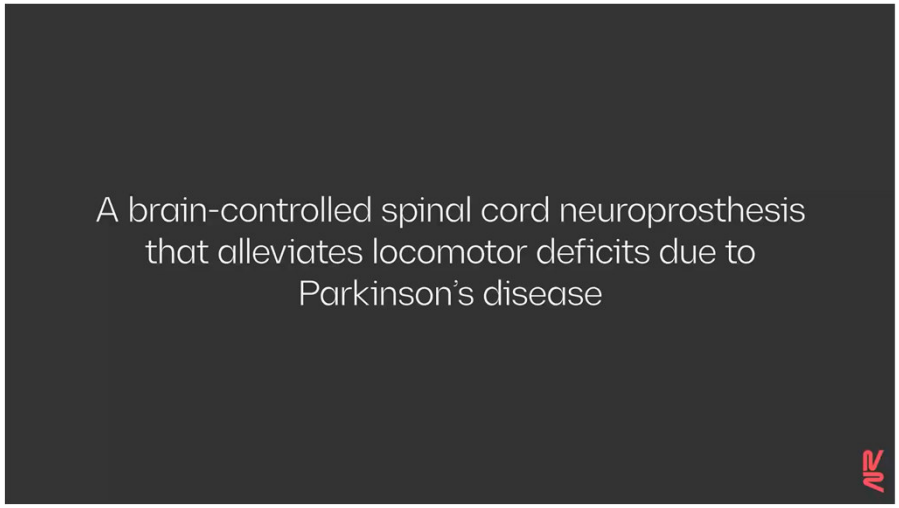

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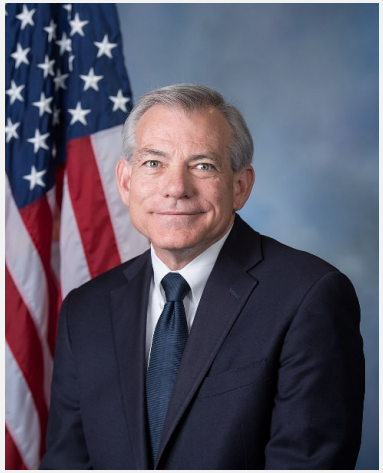
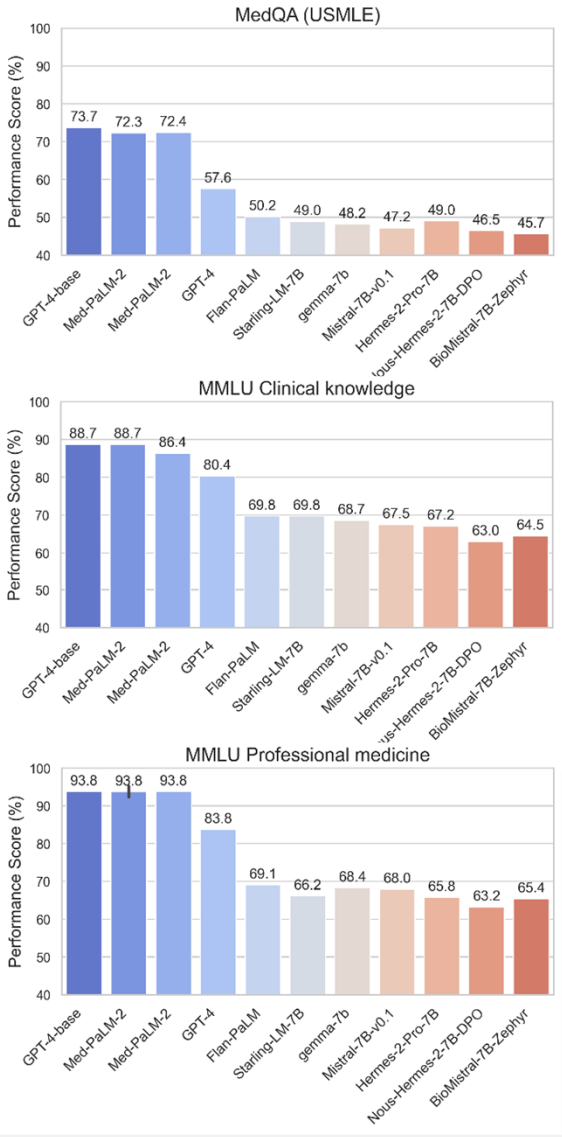
Healthy Technology Act 2025 US Leads the AI Powered Prescription Revolution

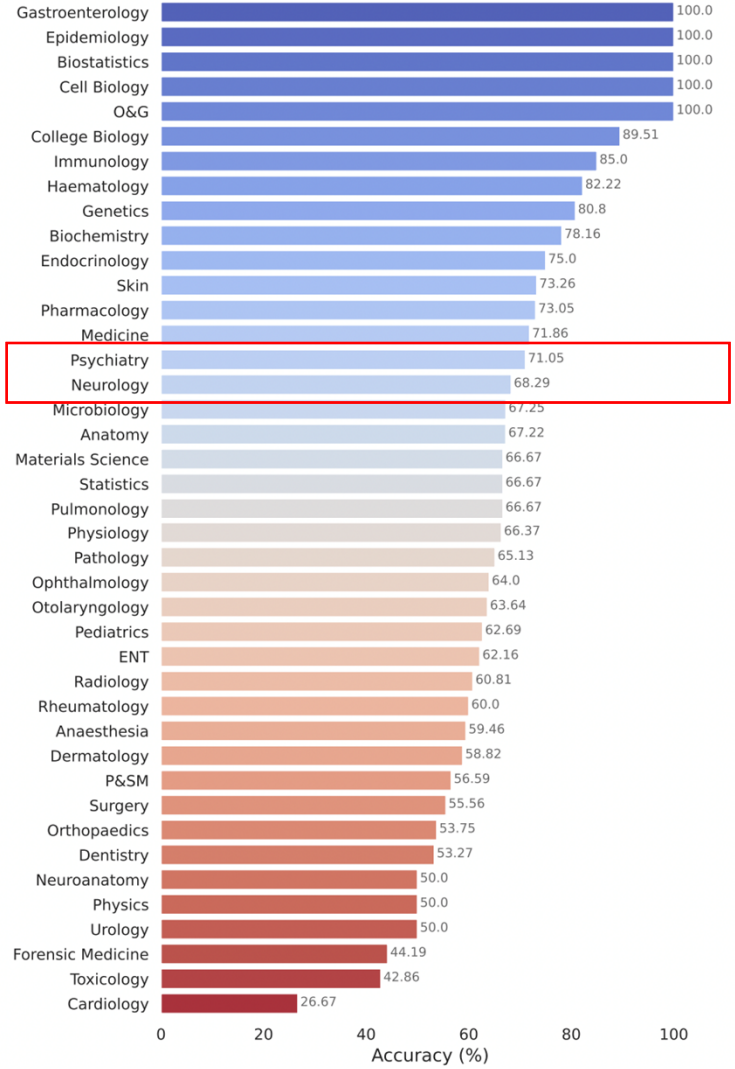
IN THE HOUSE OF REPRESENTATIVES

JANUARY 7, 2025

Mr. SCHWEIKERT introduced the following bill; which was referred to the Committee on Energy and Commerce







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WHY THE HUMAN BRAIN IS STILL SMARTER—AND MORE AMAZING—THAN AI