How Brain Imaging Can Predict and Support Stroke Recovery? From Diagnosis to Personalized Rehabilitation

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European Life after Stroke Forum 2026 | Stockholm

Disclosure Statement

There are no conflicts of interest to declare.

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ

Επιχειρησιακό Πρόγραμμα «Ανταγωνιστικότητα, Επιχειρηματικότητα & Καινοτομία – Υποστήριξη της Περιφερειακής Αριστείας» Ειδική Υπηρεσία Διαχείρισης ΕΠΑνΕΚ – Υπουργείου Ανάπτυξης & Επενδύσεων

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EPAnEK 2014-2020
OPERATIONAL PROGRAMME
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Co-financed by Greece and the European Union

Τίτλος πράξης: "Μελέτη των συσχετίσεων νευροαπεικονιστικών, νευροφυσιολογικών και εμβιομηχανικών βιοδεικτών στην αποκατάσταση του Αγγειακού Εγκεφαλικού Επεισοδίου" ΚΠ. ΟΠΣ (MIS) 5047286 ΜΟΔΥ ΕΛΚΕ ΔΠΘ ΚΕ 82595
Επιστ. Υπεύθυνος: Κωνσταντίνος Βαδικόλιας,Καθηγητής Νευρολογίας, Τμήμα Ιατρικής ΔΠΘ
Αν Επιστ Υπευθυνος: Νικόλαος Αγγελούσης, Καθηγητής Εμβιομηχανικής, ΤΕΦΑΑ ΔΠΘ

Neuroimaging, neurophysiological and biomechanical biomarkers in stroke rehabilitation (NEURO-BIO-MECH in stroke rehab)" (MIS 5047286)

Common Questions After Stroke

Will I be able to walk again?

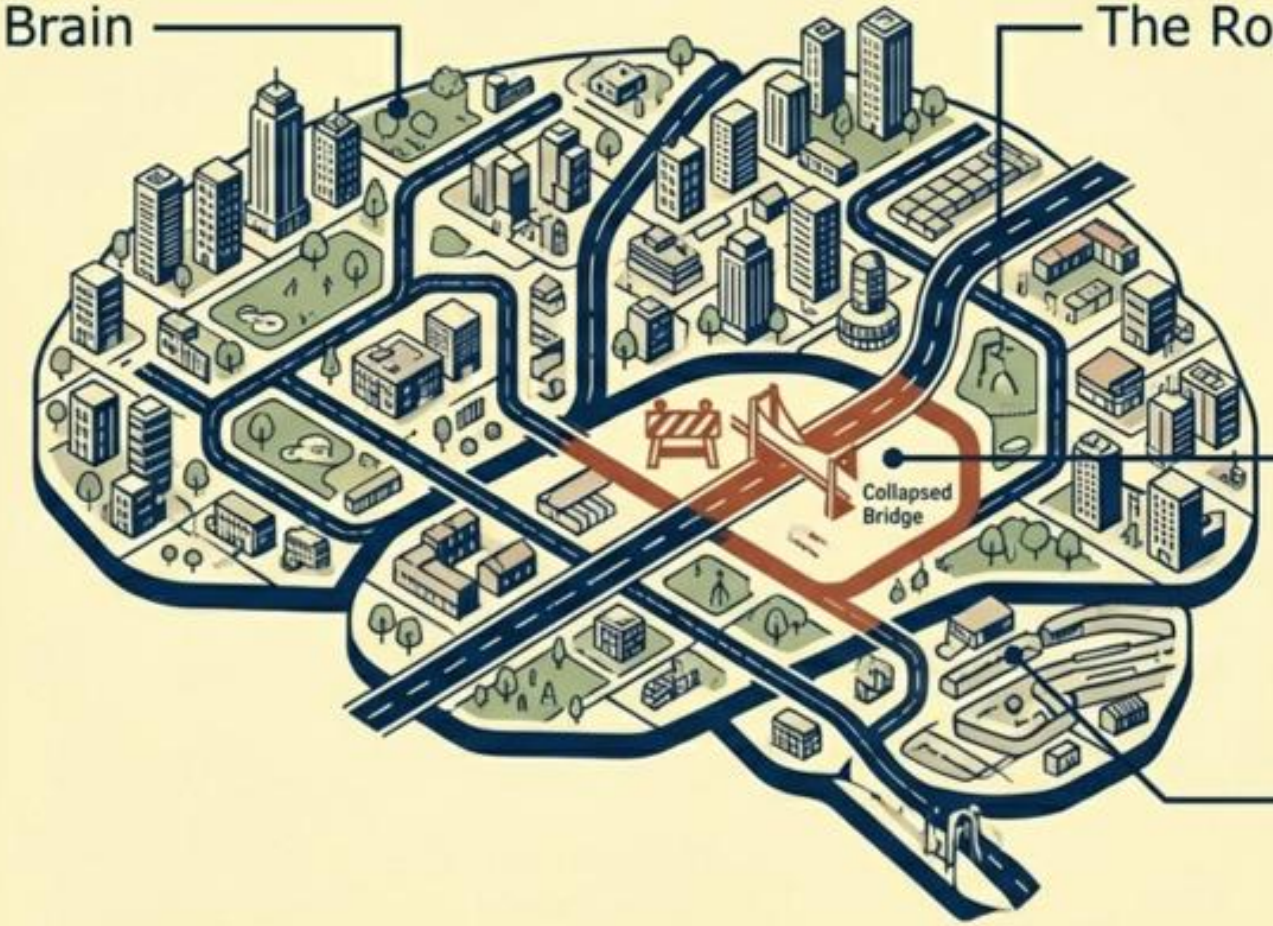
Will my arm and hand recover?

How long will recovery take?

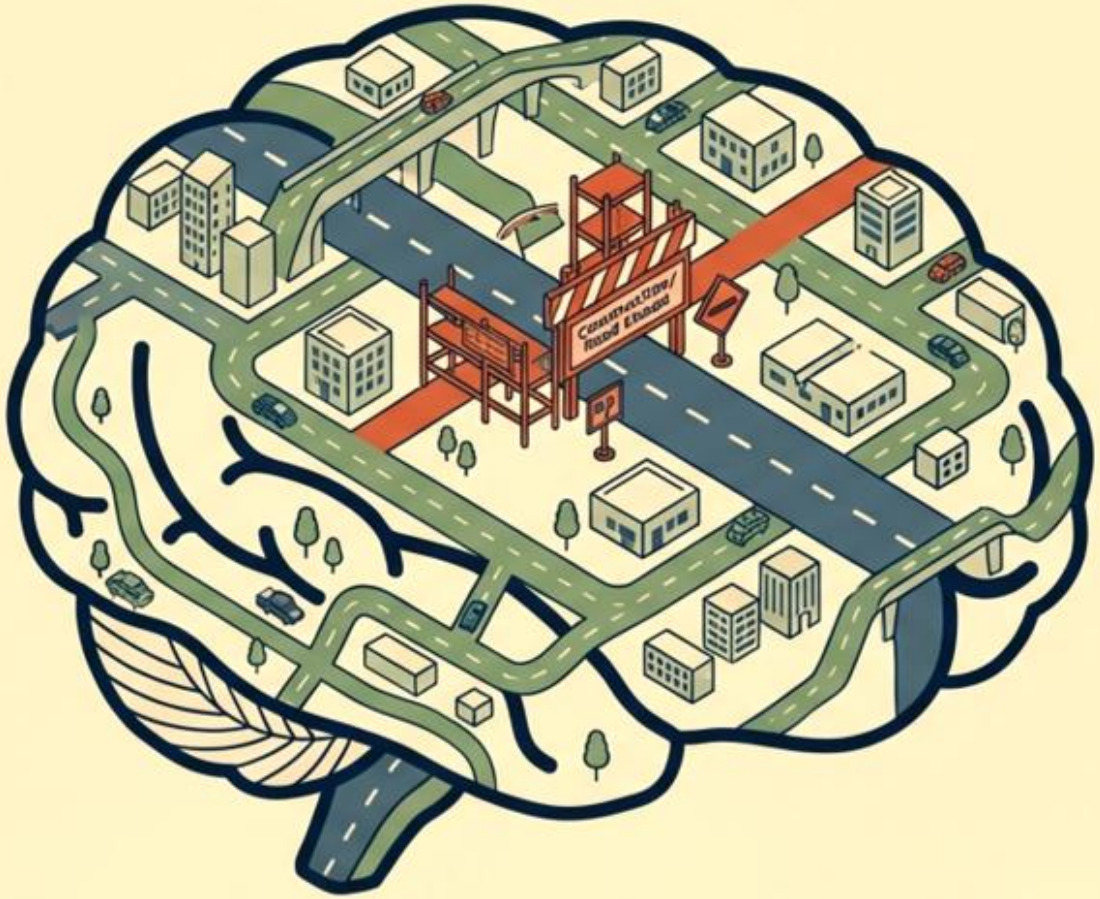
Can brain scans help predict my outcome?

Brain imaging helps us provide more accurate answers to these critical questions.

The Brain as a City



Why Recovery Differs Between People



The Brain as a City:
A complex network of roads (pathways) and bridges

The Roadblock: Stroke damages key routes

The Detour: Recovery depends on finding alternative routes (neuroplasticity)

Variable Outcomes: Location and infrastructure quality determine the path home

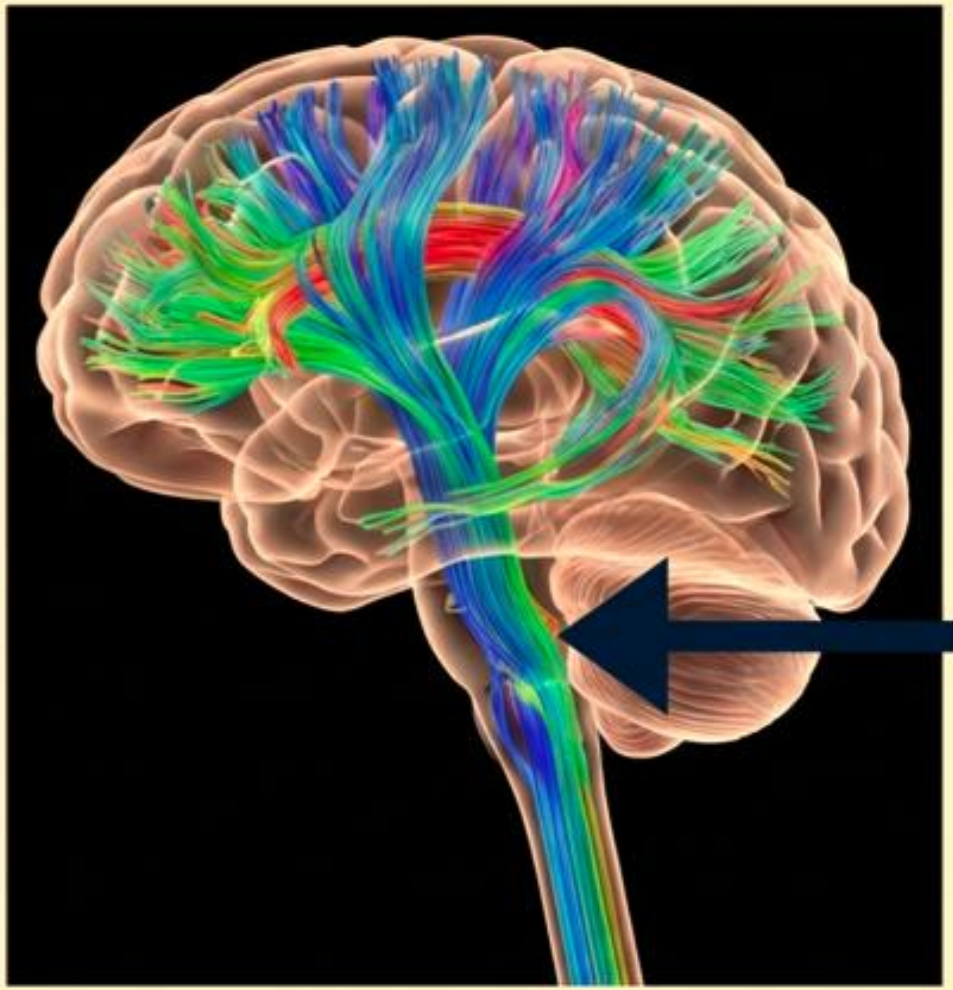
Imaging: The Surveyor of the City

Diagnostic:
Where did the stroke occur?

Prognostic:
Which pathways are damaged?
Which are intact?

Monitoring:
How is the city reorganizing?

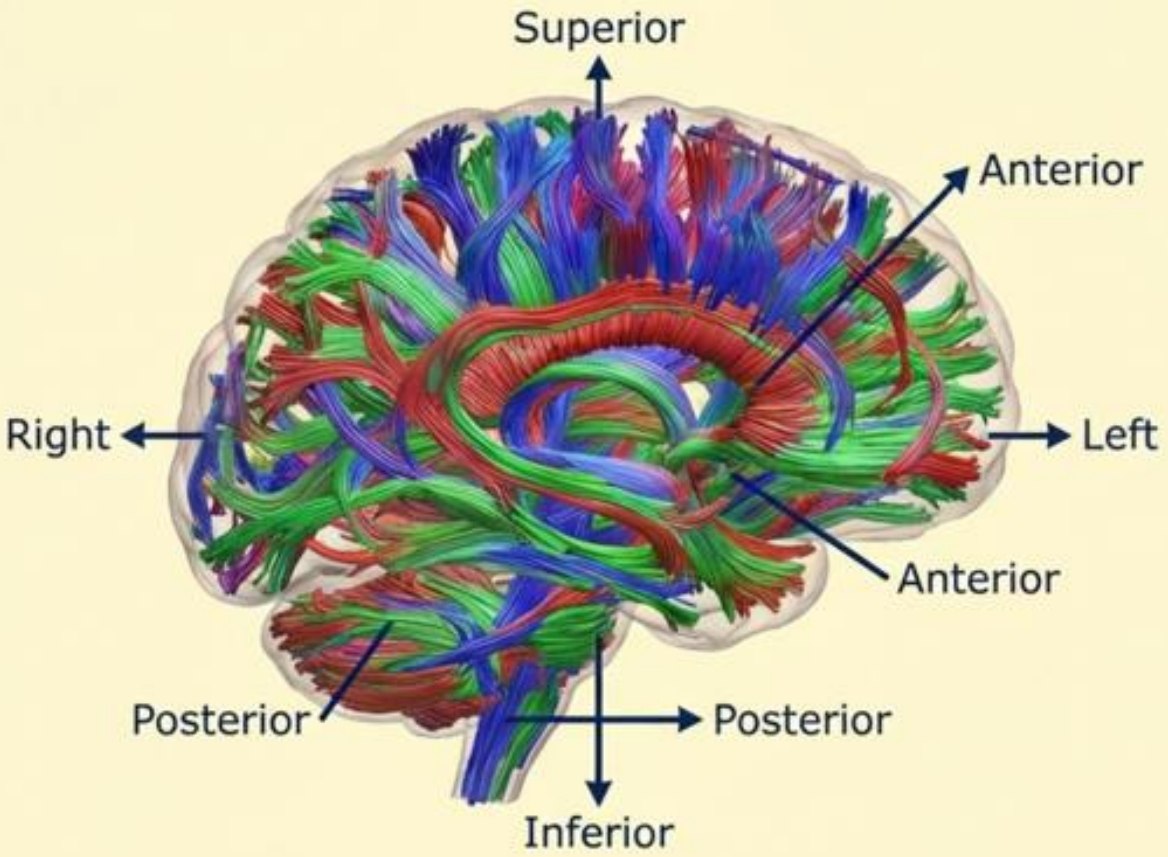
Moving around - the critical highway : corticospinal tract (CST)

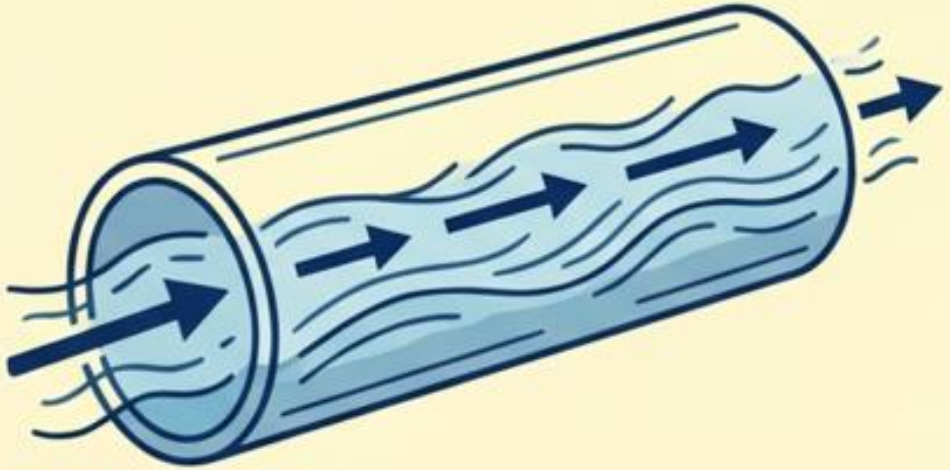


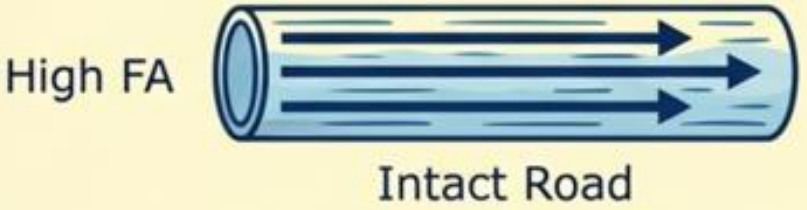
The CST is the main cable carrying signals from the brain to the spinal cord and muscles.

Like a cable between a control room and a machine: if cut, the machine cannot respond.

Diffusion MRI (DTI): Measuring Road Quality

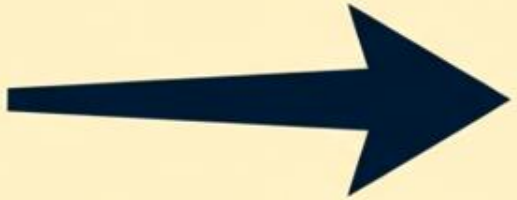






Mechanism: Tracking water movement along fibers.
Metric: Fractional Anisotropy (FA) = Pathway Integrity.

What DTI Studies Show About Recovery



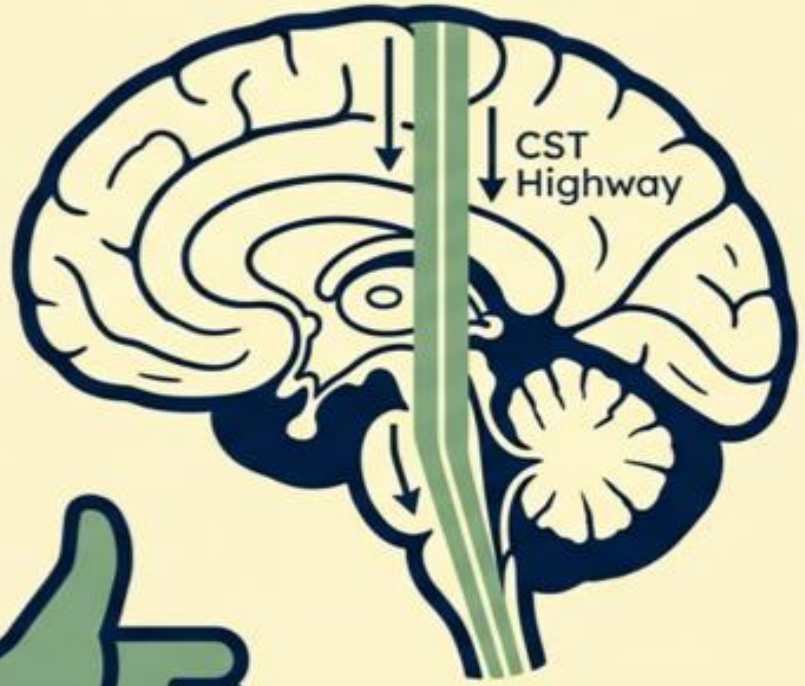
24–72 Hours Post-Stroke

Predicts 3-12 Month Outcome

- Lower FA in CST = Poorer motor outcome
- Drop in Axial Diffusivity (AD) = Weaker grip strength later
- Lower Fiber Number Ratio = Less recovery capacity

Predicting the Future: A Tale of Two Patients

Patient A



Highway Intact = Good recovery of arm function.

Patient B

Highway Severed = Limited recovery.

Early integrity of the motor pathway is a strong predictor of later recovery

Real-Life DTI Example: Two Patients

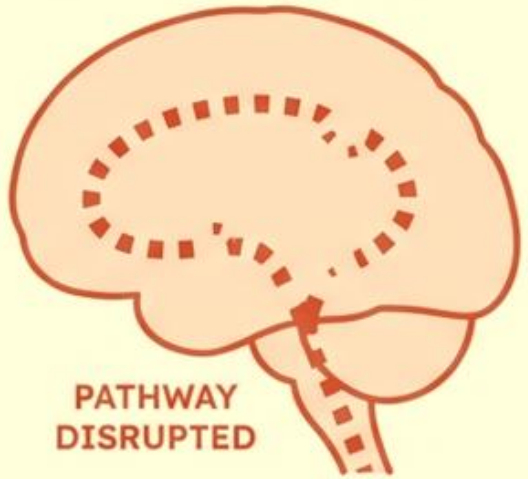
Patient A (Mild CST Injury)

CST Status: Intact pathway, preserved FA values.

Fiber Ratio: High.

3 Months: Walking independently.

Patient B (Severe CST Disruption)



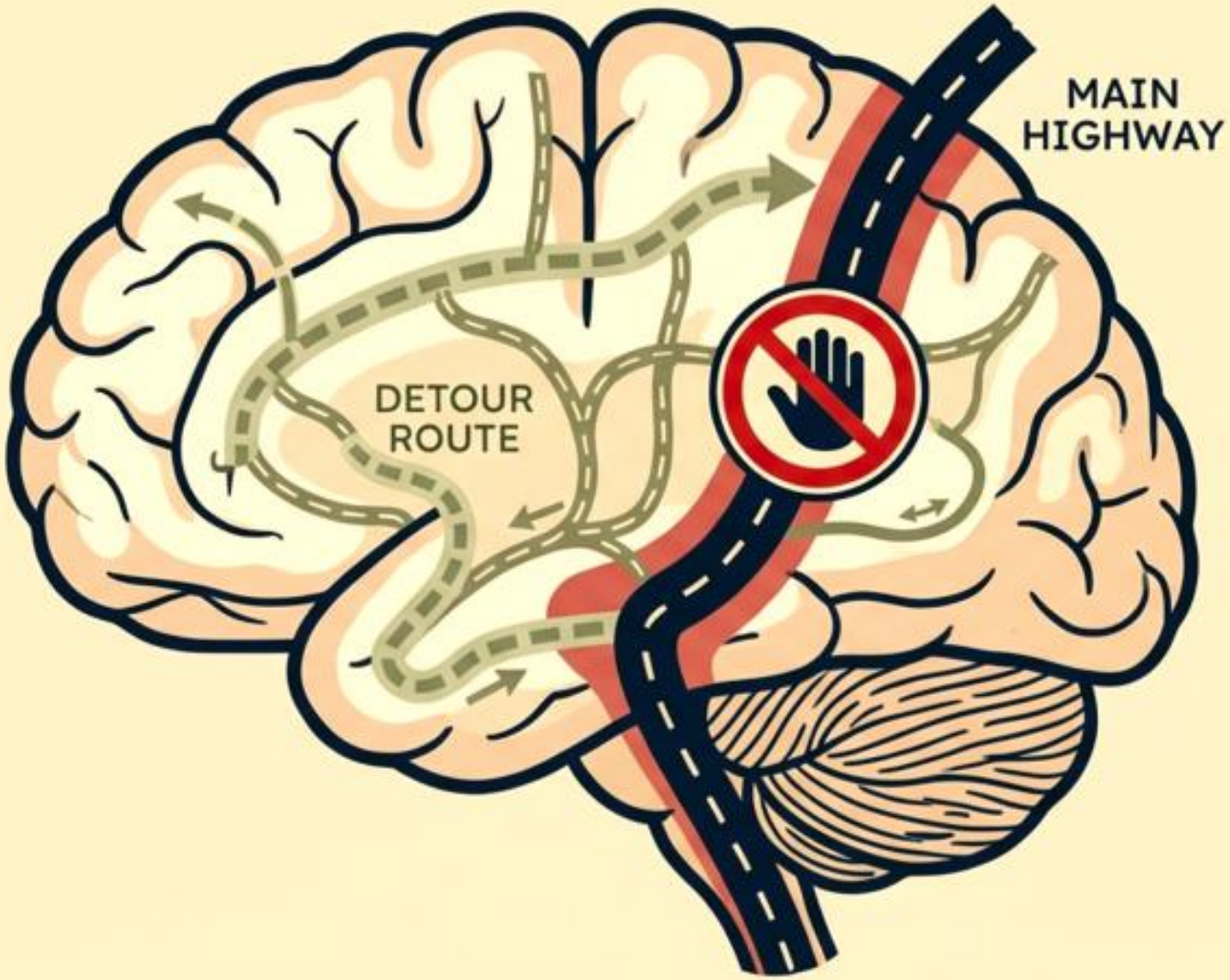
CST Status: Disrupted pathway, low FA values.

Fiber Ratio: Low.

3 Months: Needs support to walk.

Early integrity of the motor pathway is a strong predictor of later recovery

Neuroplasticity: Finding the Detour

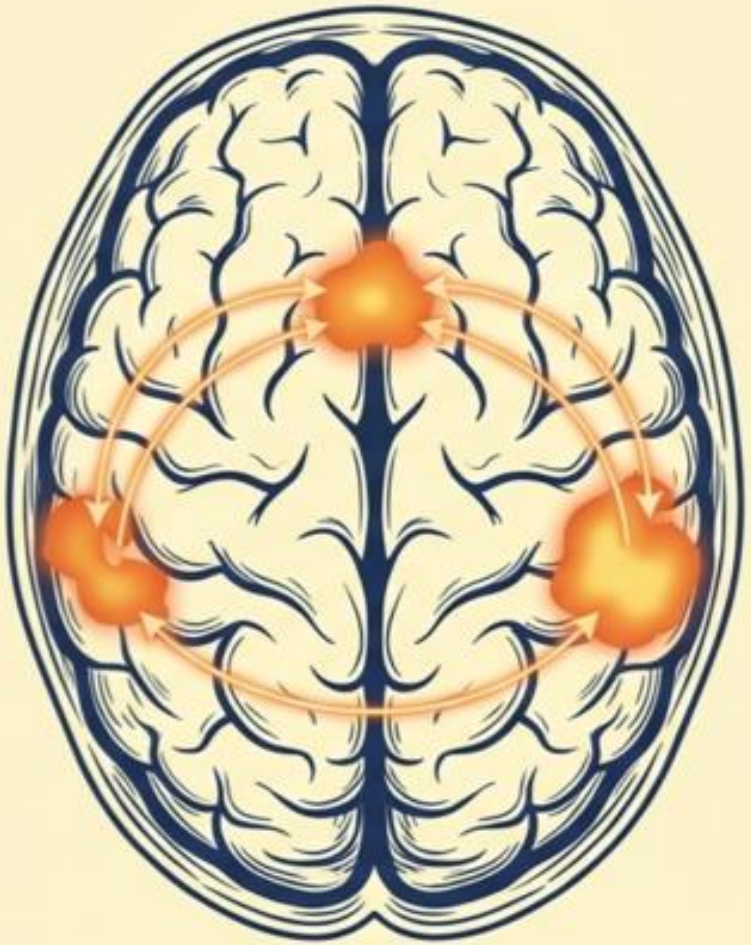


Structure is only half the story.

The brain is plastic:
If the main highway is blocked, traffic is redirected through smaller side streets.

Result: Slower process, but function can return.

Functional Imaging: The City's Software



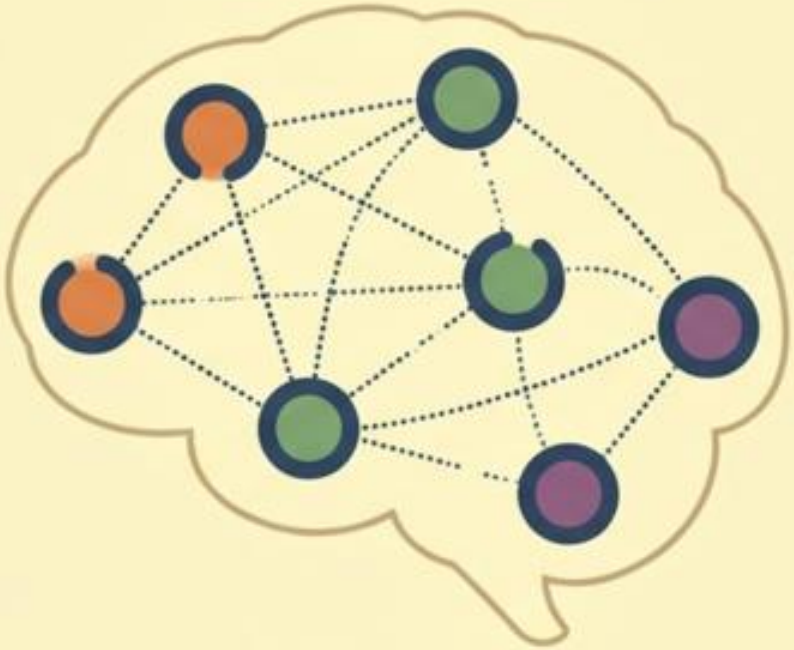
- Technique: Resting-state fMRI.
- The Analogy: Checking if the phone lines between city districts are working, even when no one is speaking.
- Measures communication at rest (no task required).

Connectivity as a Predictor

Strong Connectivity

Motor areas are "talking" to each other = Better Recovery.

Weak Connectivity



Communication silence = Slower Recovery.

What rs-fMRI Shows About Recovery

Strong Connectivity = Better Hand Outcome

Loss of Connectivity = Worse Function

Timing: Biggest changes occur in the first 4 weeks post-stroke.

Sensory Recovery: Strong Left-Right S1 connectivity predicts better touch sensation.

Key Insight: Interhemispheric communication is the gold standard for prediction.

The Complete Picture: Hardware + Software

Structure
(DTI/Hardware)

+

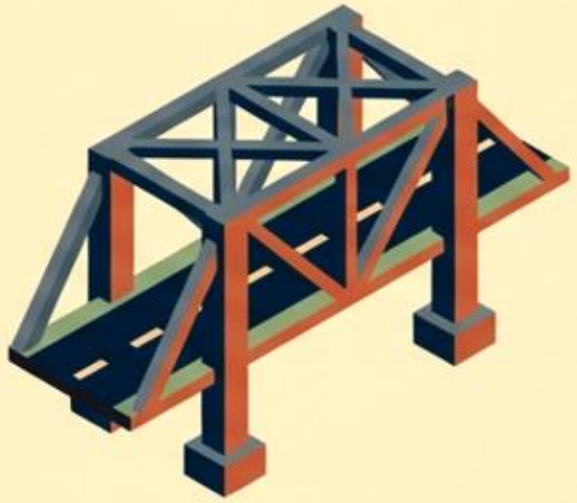
Function
(fMRI/Software)

=

The most accurate picture of recovery potential.

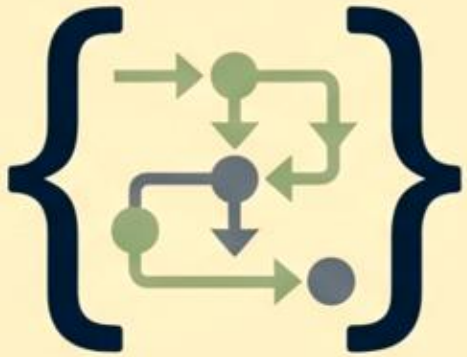
The Surveyor's Tools: Mapping the City

Structural Imaging (DTI)



The Hardware: Checks the pavement quality and physical road integrity.

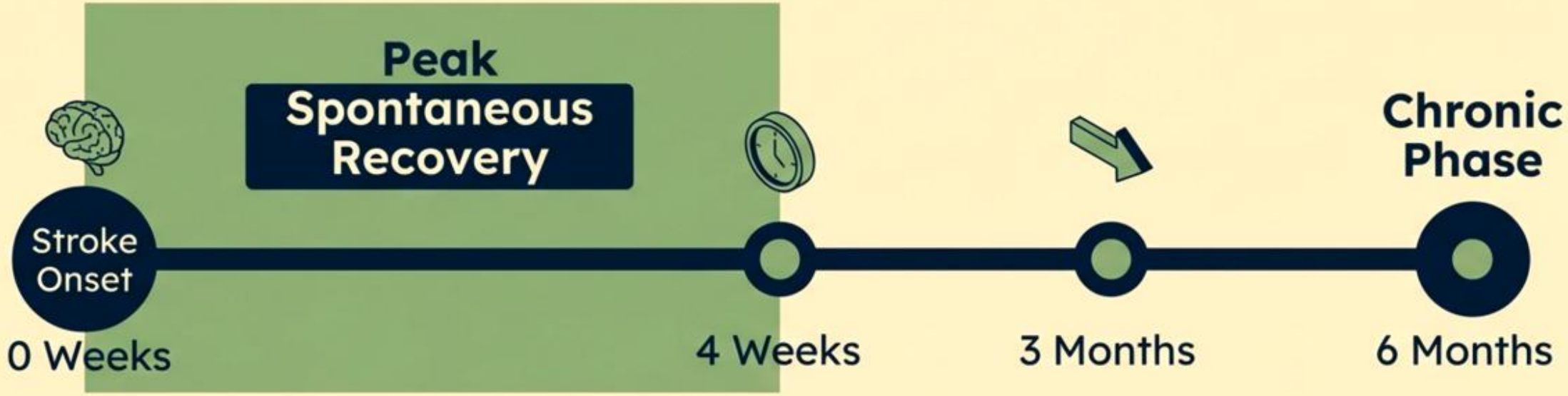
Functional Imaging (rs-fMRI)



The Software: Checks the traffic flow and communication at rest.

Moving from "Where is the stroke?" to "How is the network functioning?"

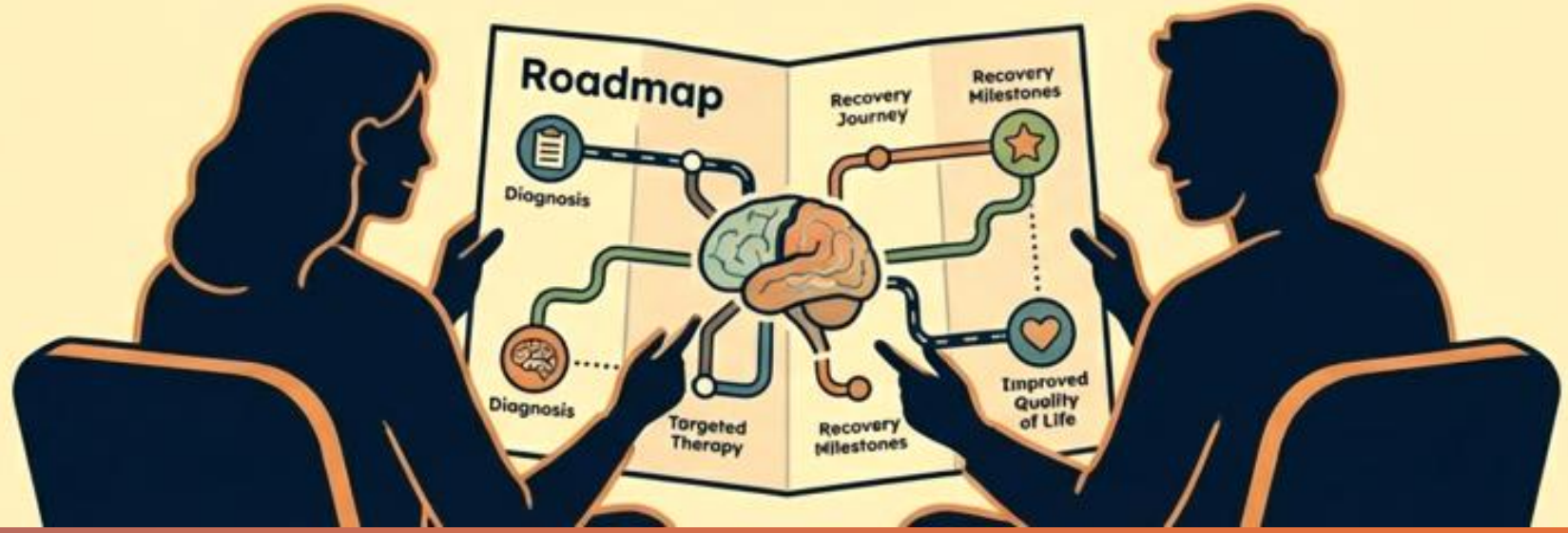
The Window of Opportunity: Neuroplasticity

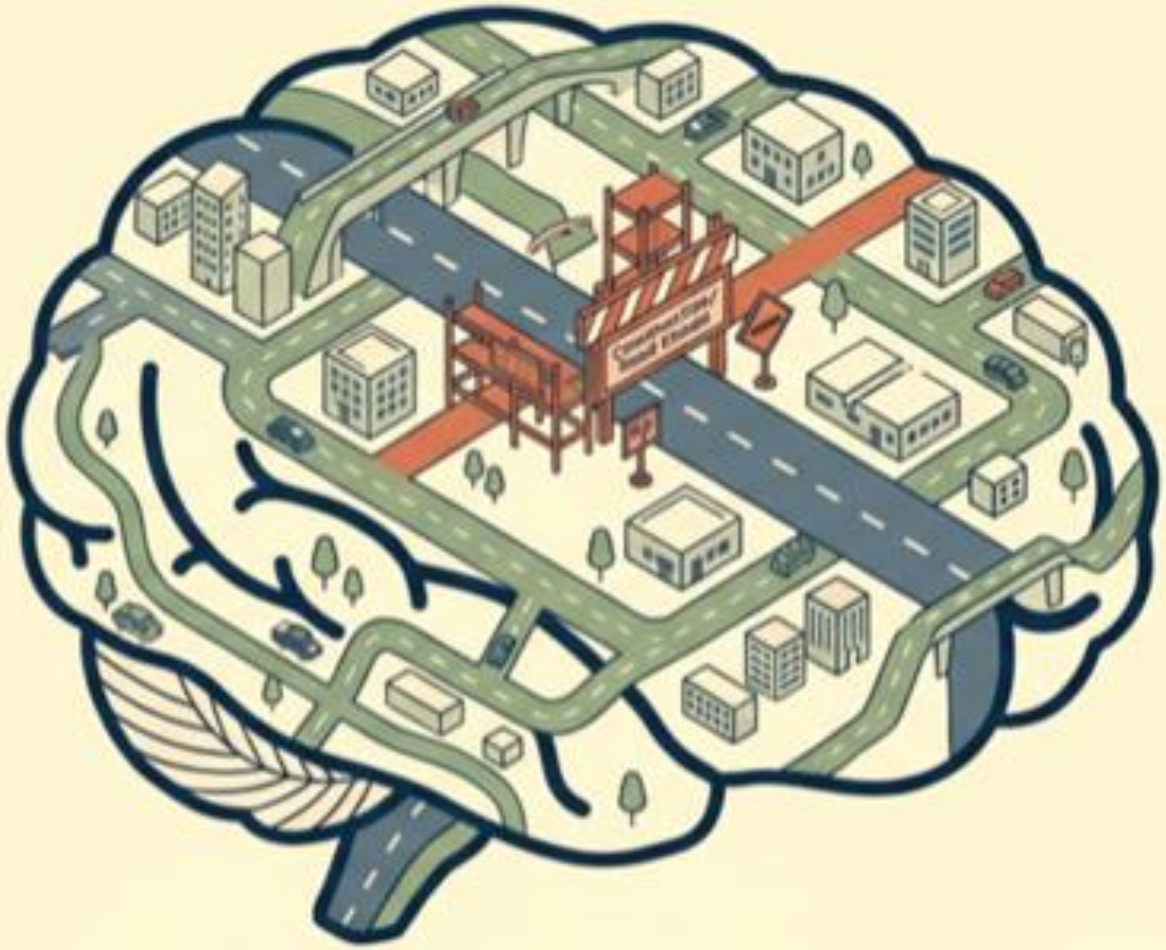


Surviving networks attempt to rewire immediately.
Imaging allows us to visualize these changes in real-time
to steer therapy before the window closes.

What This Means for You

Reduced Anxiety	Better Planning	Personalized Care
Replacing "wait and see" with data-driven expectations.	Decisions about work and home support.	Treatment tailored to YOUR specific brain network.





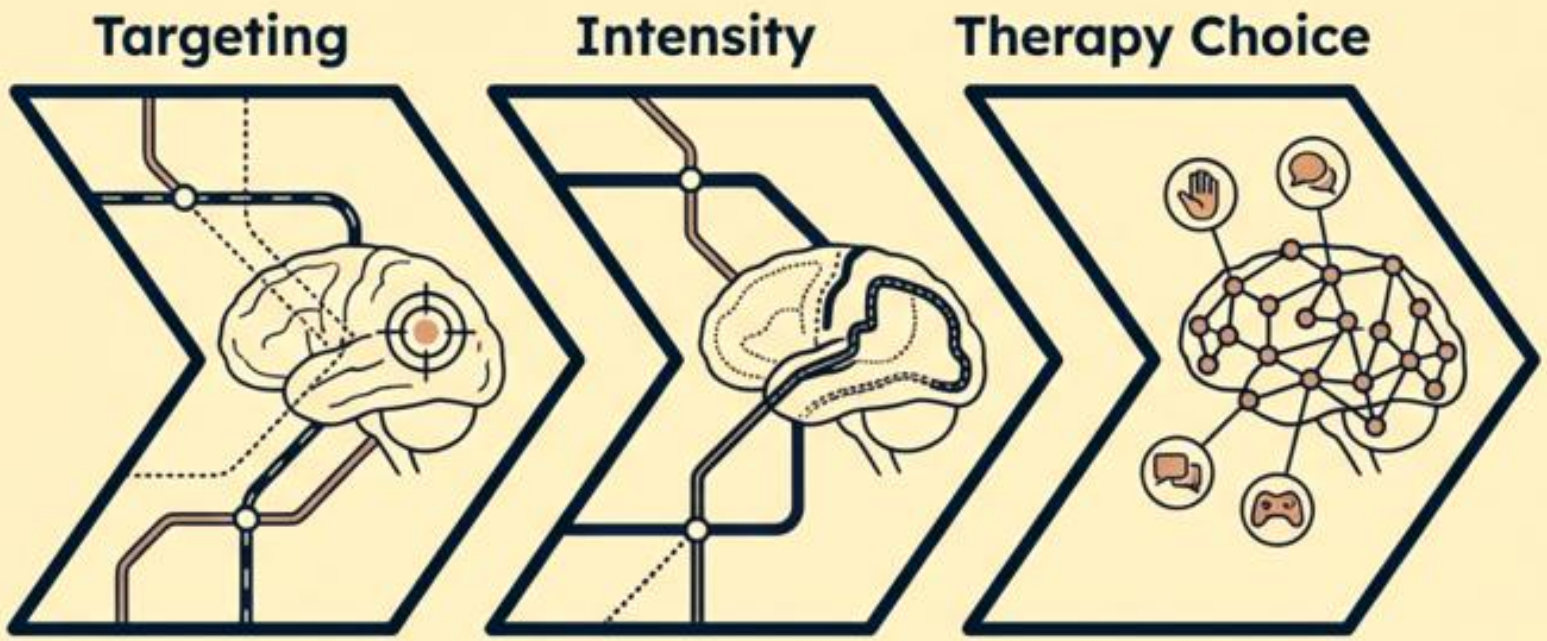
What This Means for You

Less Uncertainty: A clearer roadmap of what to expect.

Personalized Plans: Treatment based on *your* brain's specific map.

Empowerment: Information helps you plan for daily life and return to work.

From Scans to Personalized Rehabilitation



Targeting
Identifying brain areas for stimulation (e.g., rTMS).

Intensity
Matching rehab intensity to road integrity.

Therapy Choice
Selecting therapies that fit the remaining network.

Take-Home Messages

- Stroke affects **networks**, not just single areas.
- **Imaging** reveals both the damage (roads) and the potential (detours).
- The brain can **reorganize** (neuroplasticity).
- Advanced scans help us move from ‘one size fits all” to **personalized rehabilitation.**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Thank you for your attention !