

Design of Technologies for Children: User Needs as a Starting Point

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User needs are the starting point — not a validation checkpoint

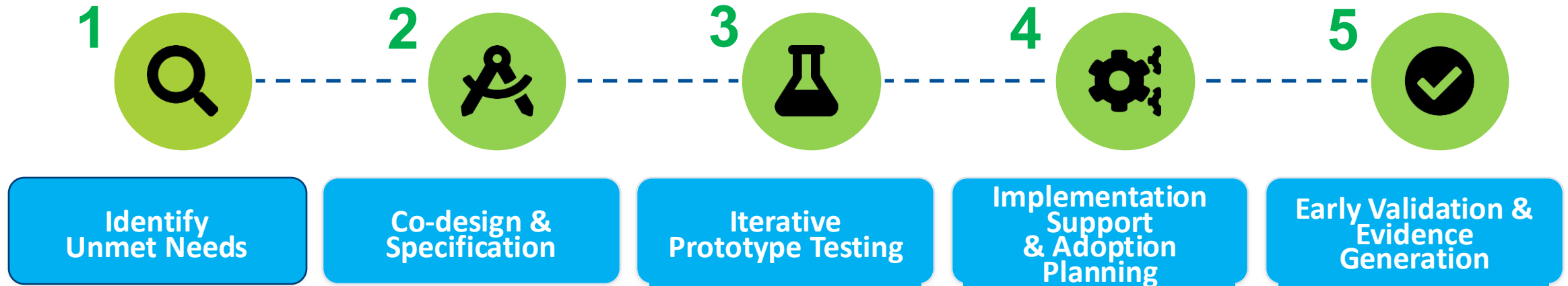
Across pediatric rehabilitation technology, the difference between sustained adoption and quiet abandonment traces back to one question:

What do children, caregivers, and clinicians actually need — as voiced in their own words & in their own real-world context?

This needs to be asked and asked yet again throughout the child's rehabilitation (and beyond)

Five Stages of Product Design

Primary stakeholders at each stage



Whose needs? Three user types three different lenses



Children

Engagement &
accessibility



Caregivers

Burden &
feasibility



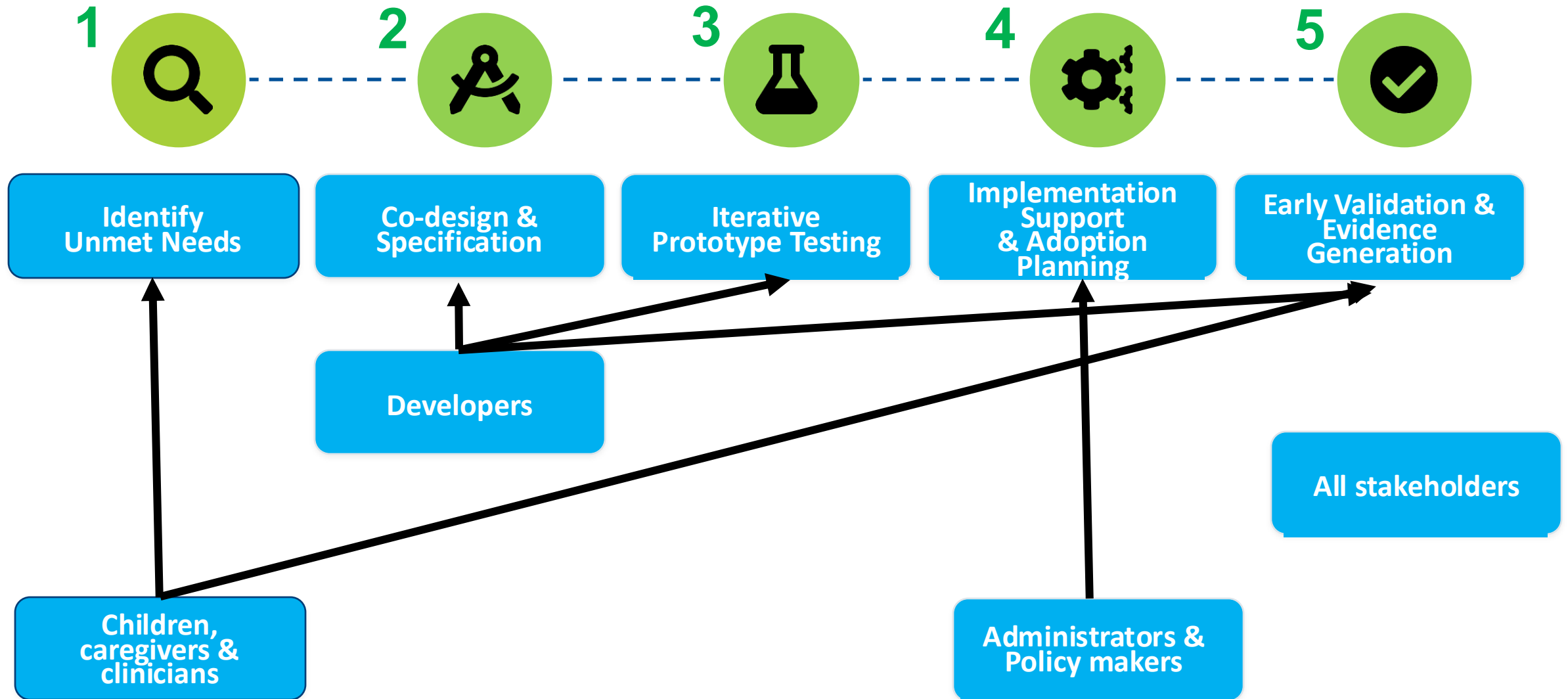
Clinicians

Workflow &
therapeutic relevance

Effective co-design must satisfy all three simultaneously — and reconcile their real-world experience when priorities diverge

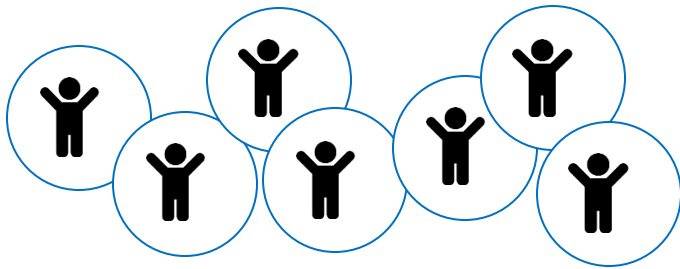
Five Stages of Product Design

Primary stakeholders at each stage



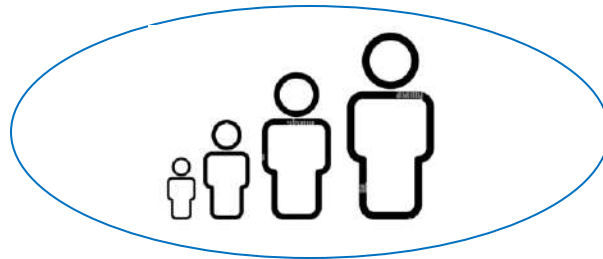
The Challenge: Pediatric user needs are unusually hard to pin down

- Digital and assistive rehabilitation technologies are expanding rapidly — yet many never achieve sustained clinical use
- Root cause is rarely the engineering
- It's that the need was never fully captured in the first place



Not one user, but many

Children, caregivers, and clinicians are simultaneous end users — with different, sometimes conflicting, needs



Needs shift with development

Heterogeneity in diagnoses and developmental stages means a need at for a child with CP at age 4 may not hold for a child with ABI at age 10



Needs are context-dependent

A need identified in clinic may look completely different at home or at school

How to Identify unmet needs

- Determine who is the target population and context of use
— clinic, school, or home
- Define the clinical problem directly with end users, informed by their lived experience
- Assess whether existing solutions are adequate; identify gaps and constraints
- Translate needs into functional requirements and safety considerations

Methods that generate real evidence of need



Clinical observation

of real-world use, not staged demonstrations

Methods that generate real evidence of need

Focus Groups of Professional Experts



Focus groups

Identifying needs no single stakeholder sees alone



Methods that generate real evidence of need



Needs-assessment interviews
with children, caregivers & clinicians



Task-specific activities
across clinic, school & home contexts



Summary of Methods to.....

Explore needs

Ethnography
Interviews
Diary keeping
Cultural probes
Focus groups
Observations
Task Analysis

Translate needs into design features

Written Storyboards
Pictorial Storyboards
Physical models
Mock-ups
Simulations
“Wireframe” prototypes
Functional prototypes
High-fidelity prototypes

Evaluating whether need was met

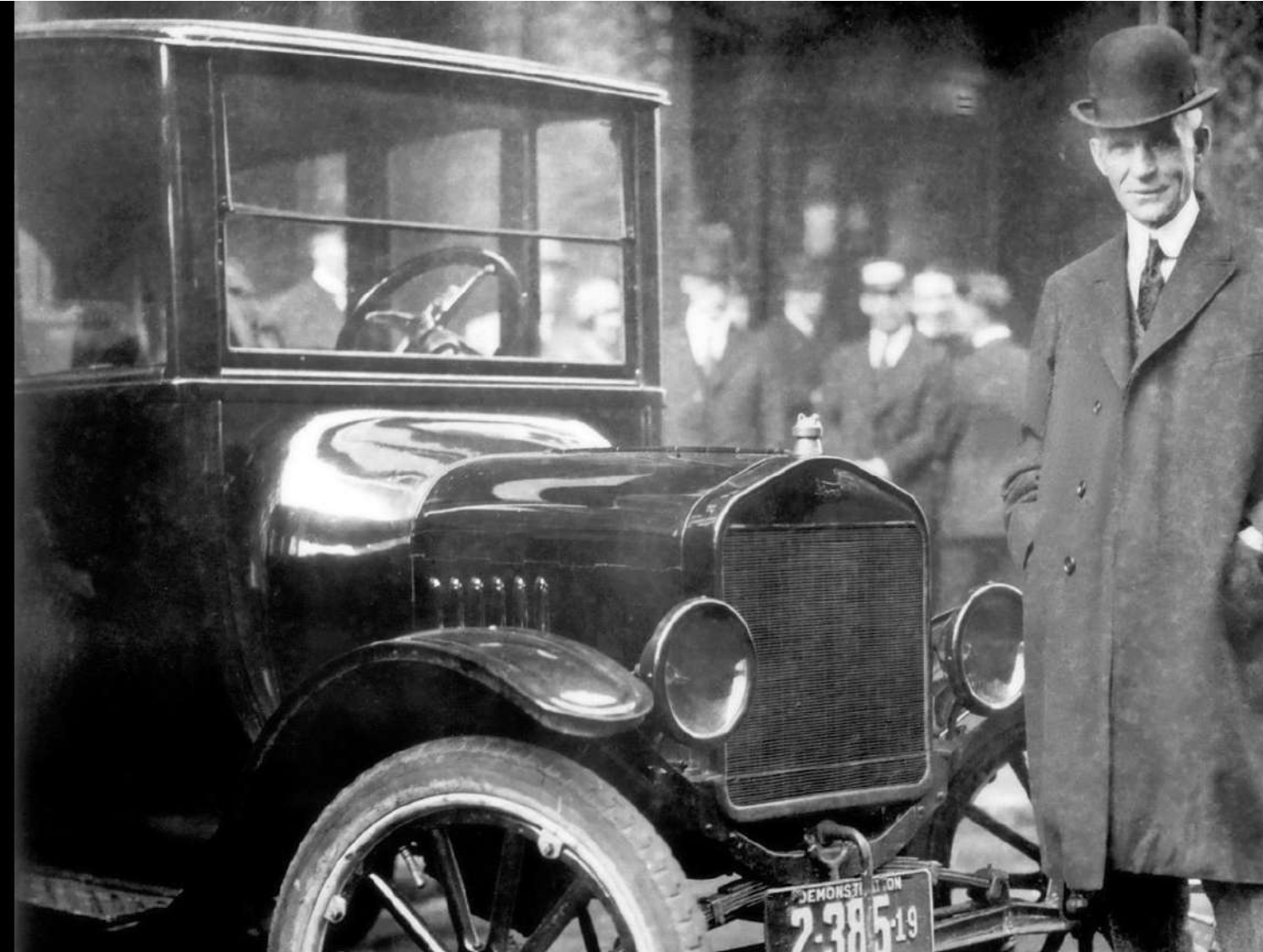
Verbal Protocol Analysis
Usability tests
Performance trials
Wizard of Oz trials
Interviews
Questionnaires

However

Designers and users do not necessarily know how to communicate with each other



Or they think they know best



"If I'd asked people what they wanted, they'd have said faster horses".

Henry Ford

Or they think they know best



"It's really hard to design products by focus groups. A lot of times, people don't know what they want until you show it to them."

*Steve Jobs, BusinessWeek
May 25, 1998".*

January 9, 2007, Apple's Macworld Conference & Expo, San Francisco

AP / Paul Sakuma

Example 1 — NEEDS IDENTIFICATION

The unmet need: Solving cold weather's threat to independent powered wheelchair mobility



Example 1 — NEEDS IDENTIFICATION

Results from interviews and focus groups with 13 males with Duchenne Muscular Dystrophy, aged 15-43 years

- Cold weather ($<17^{\circ}\text{C}$) rapidly worsens hand & grip fatigue, especially after age 12
- Reduced grip control threatens safe, continuous powered-wheelchair operation
- Ordinary mittens and gloves don't preserve joystick dexterity
- Repeated loss of outdoor mobility limits community participation

Translating user need → Design requirement → Production

Anatomy of the Prototype



Acrylic Structure:
Transparent housing
positioned over the hand
and joystick to trap heat.

Heating Mechanism:
Internal electric
heating elements.

Thermal Shroud:
Exterior fabric wrapping to
conceal mechanisms and
insulate the chamber.

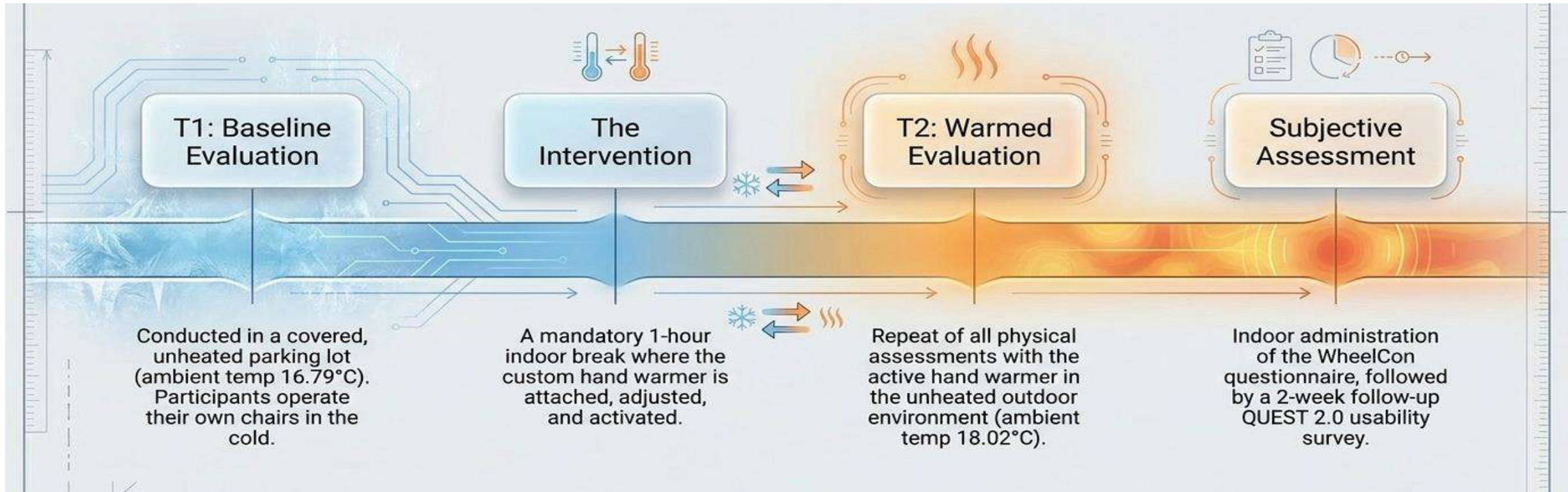


Flexible Arm:
Adjustable positioning
stalk.

Quick-Release Base:
Mechanism attached
directly to the wheelchair
frame for rapid
installation/removal.

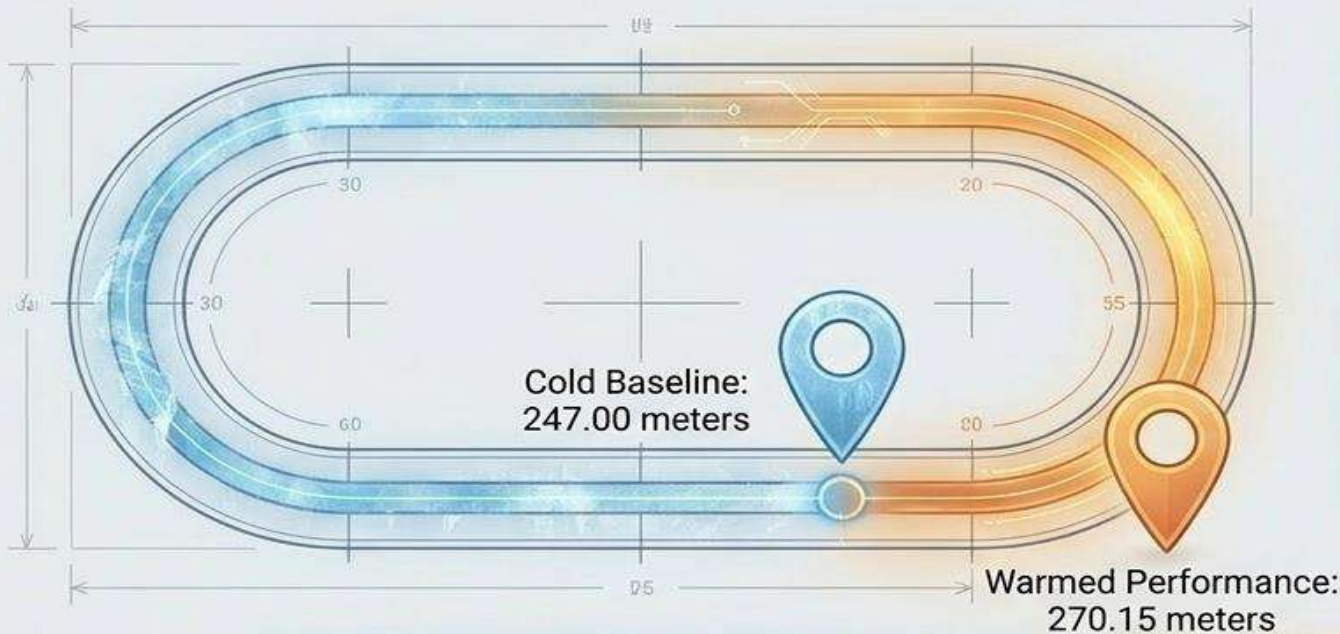
Power Source:
Standard USB cable
routing to a portable
battery pack.

Evaluating the Product



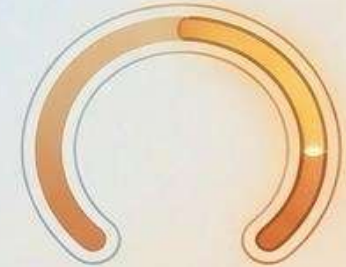
Evaluating the Product

Empirical Validation: Sustained Endurance



+23.15
meters gained.

**Statistically
Significant**
($p=0.02$)



Large Effect Size
($r=0.63$)

Maintaining local thermal regulation directly translates to sustained capacity for continuous joystick operation, combating the rapid muscle fatigue inherent in DMD.

Evaluating the Product

Empirical Validation: Wheelchair Use Self-Efficacy



Baseline state:
71.00

Warmed state:
81.62

**Highly
Significant**
($p=0.008$)

**Very Large
Effect Size**
($r=0.74$)

Beyond physical capability, the thermal intervention dramatically restored user confidence in mobility and self-management—a metric heavily correlated with actual real-world community participation.

But there are limitations

“

*The hand returned to itself...
it's nice, it warms the hand
and it's not cold.*

The thermal theory is definitively proven. The biological barrier of cold can be mitigated by localized heat.

“

*It's difficult in narrow spaces.
The problem is that the device
moves all the time... it wasn't
stable.*

The physical form factor creates secondary environmental barriers. True assistive technology must integrate seamlessly into spatial environments.

Example 2 — NEEDS IDENTIFICATION

The unmet need: Lack of biomarkers to guide medication & treatment during rehabilitation of children with Acquired Brain Injury (ABI)



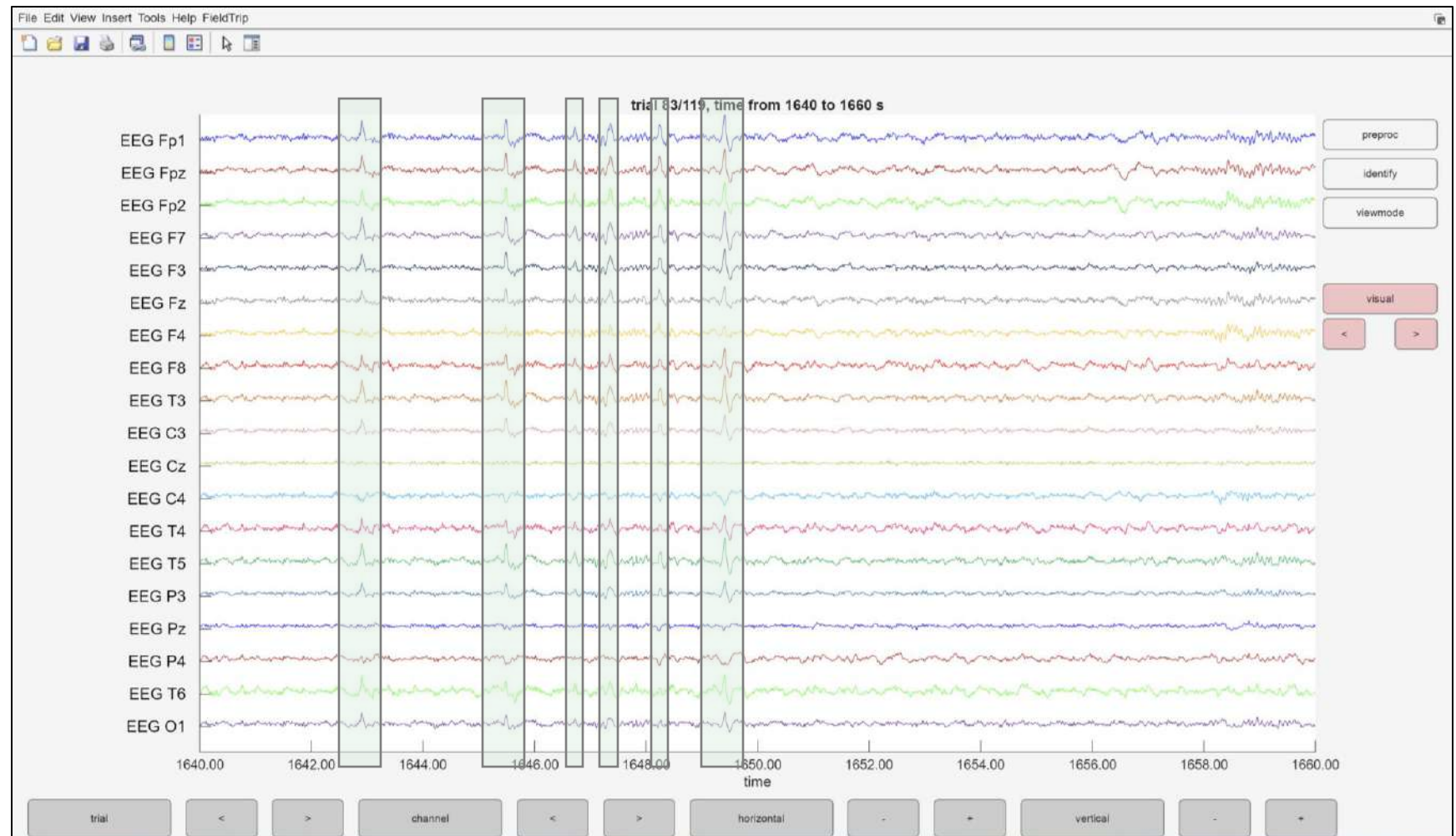
Example 2 — NEEDS IDENTIFICATION

Results from 1-year retrospective review of 31 children with moderate–severe ABI and parental questionnaires

- Post-injury epilepsy & neuropsychiatric morbidity are common after pediatric ABI
- Typically EEG is recorded at start of rehabilitation & not repeated
- At ALYN, multiple EEG recordings made over 1-year of rehabilitation to identify potential EEG-based biomarkers for clinical prognosis, response to medication, long-term functional outcomes
- Mean age at injury of this cohort = 9 years; median Glasgow Coma Scale 7; 71% of ABI was blunt trauma

EEG Data analysis: Identifying features of interest

EEG recording from 1 patient

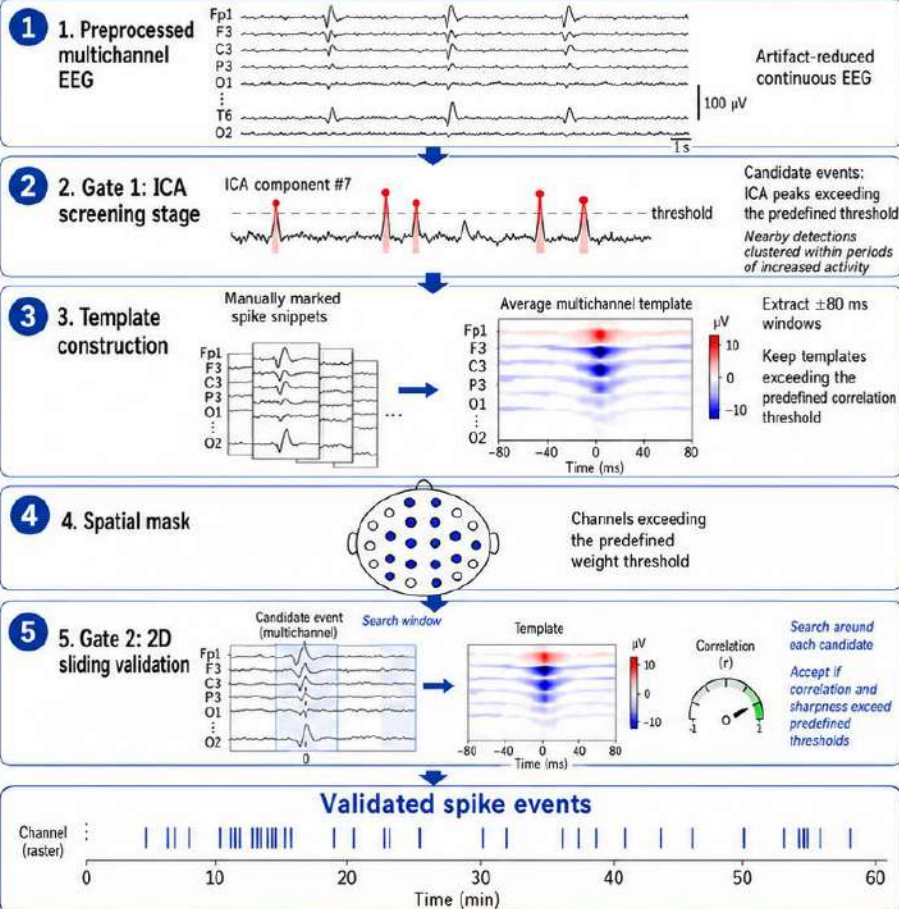


How EEG biomarker quantification responded to need

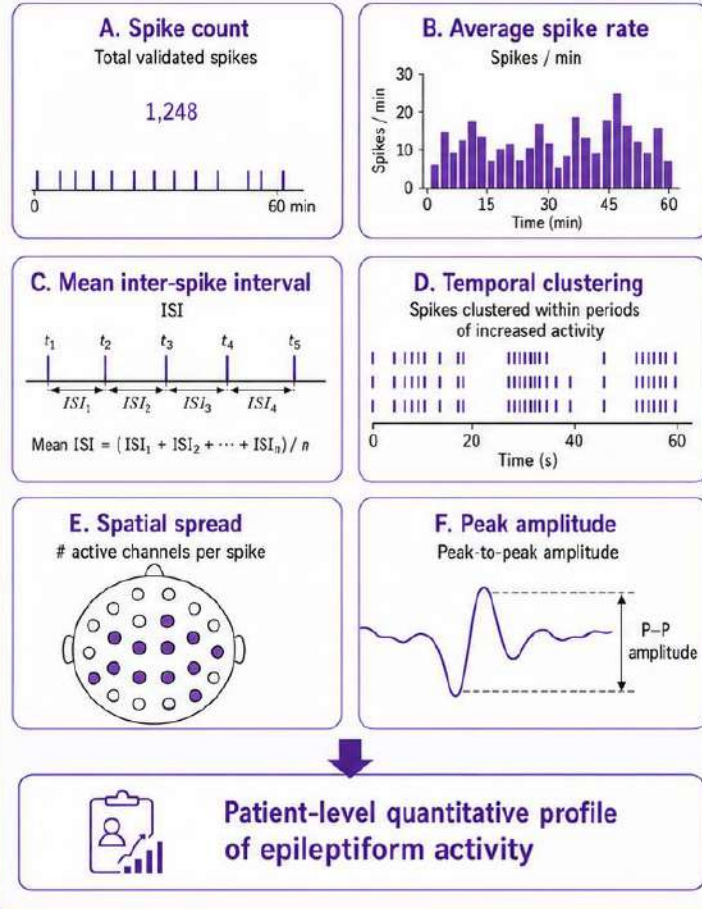
Automated Spike Detection and Spike Burden Quantification

From multichannel EEG to quantitative measures of epileptiform activity

1 Automatic spike detection

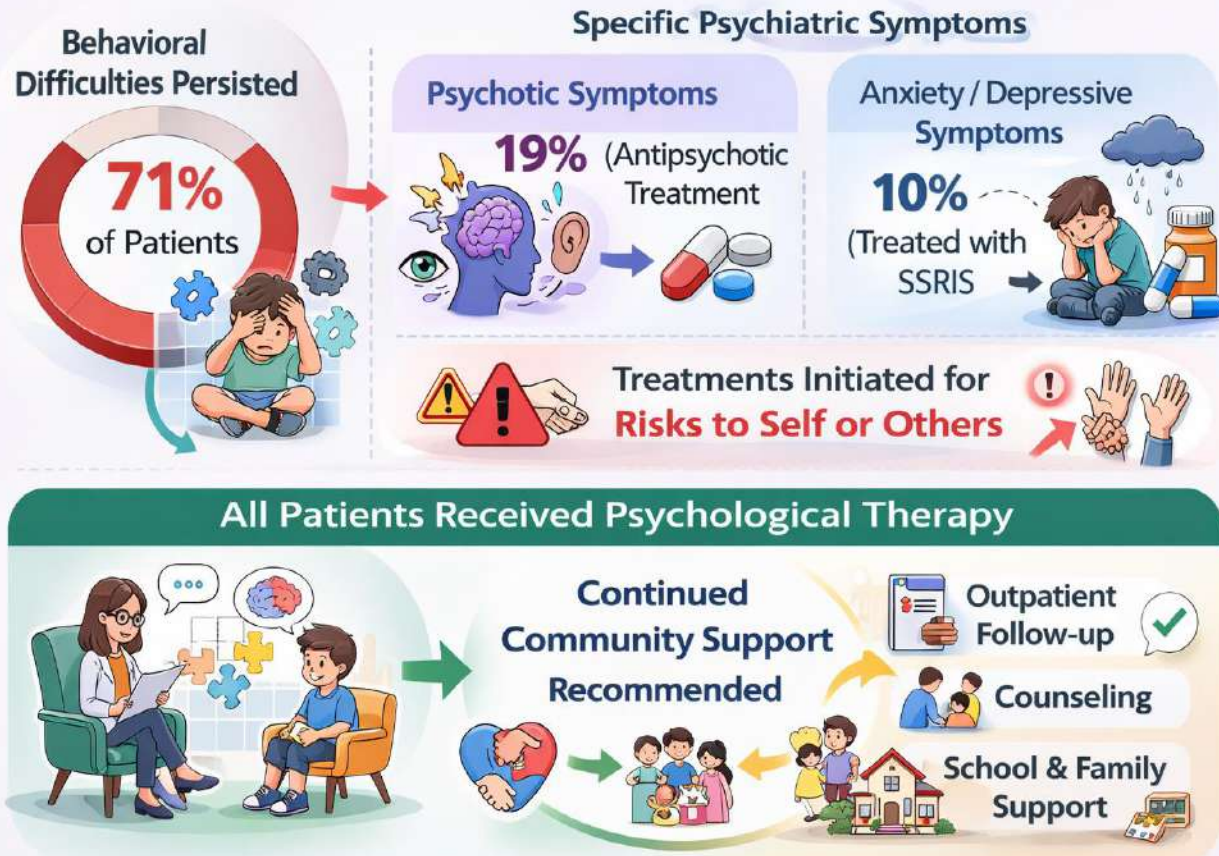


2 Quantitative outputs



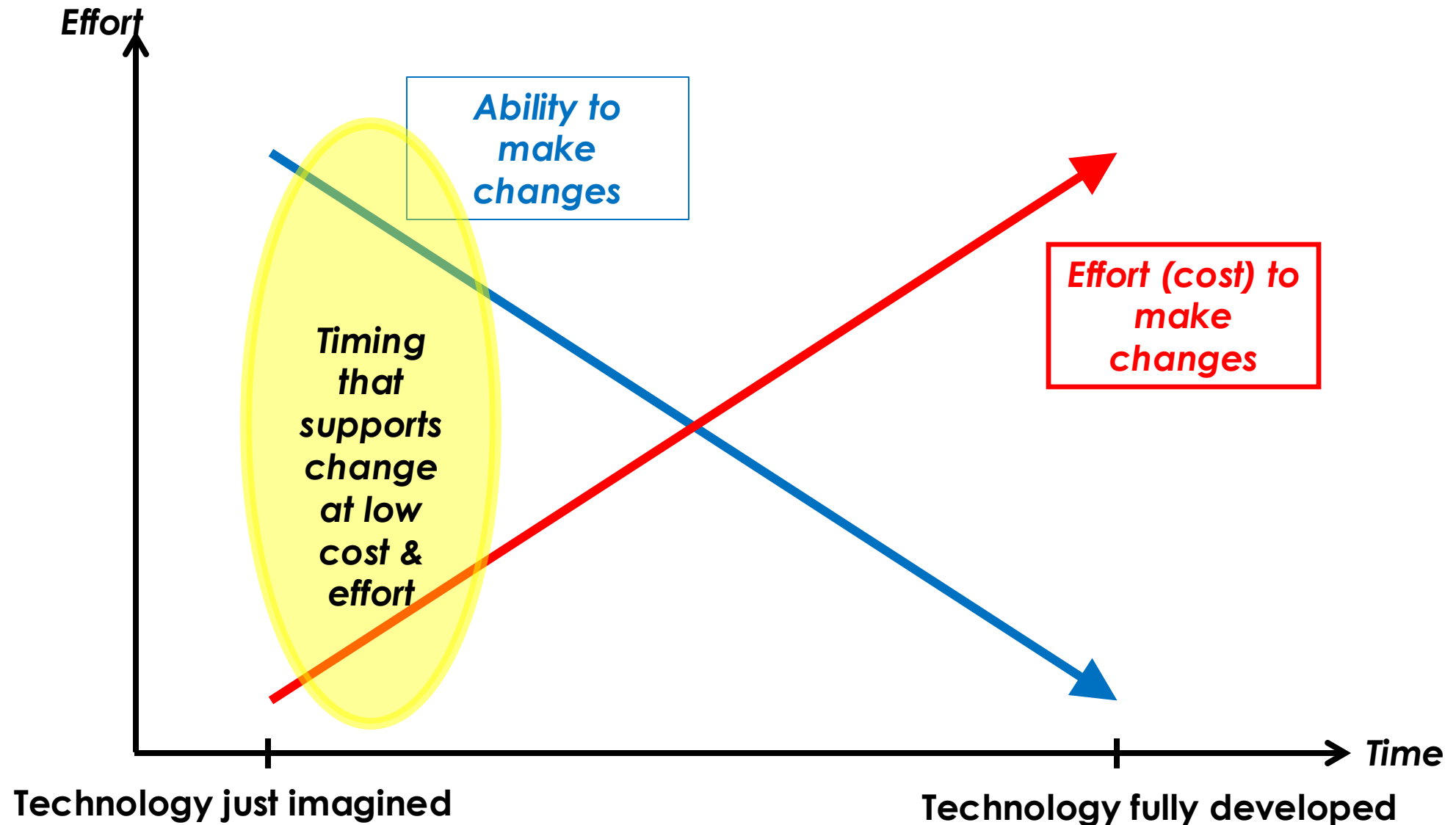
What EEG biomarker quantification has revealed (to date)

Psychiatric Clinical Course



- higher rate of late-onset seizures & psychiatric complications when EEG showed emergent epileptiform activity
- EEG normalization at follow-up was associated with more favorable clinical recovery — the EEG trajectory itself behaves like a biomarker of need

Timing of identifying user needs in co-design



In summary

- 1 Begin with validated unmet needs & measurable clinical objectives — before building anything
- 2 Engage children, caregivers & clinicians throughout all five stages, not just at kickoff
- 3 Document how each need became a design requirement, for traceability & regulatory alignment
- 4 Revisit needs iteratively — lived & clinical experience will identify needs not seen at first

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IMPACT
FACTOR
2.6

CITESCORE
4.5

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