An open-source neuromotor research framework for measurement and repeated biofeedback practice

Designed for research involving post-stroke, traumatic brain injury, and other acquired neurological injury populations

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fourgestures.org

CLINICAL AND RESEARCH BOUNDARY

The Four Gestures Battery, SQUEEZE SYNC, and all related protocols, software, hardware concepts, and reports are experimental and unvalidated. They are not intended to diagnose, screen for, confirm, exclude, classify, localize, prognosticate, or guide treatment for any condition.

START HERE

Five-Minute Clinical Brief

Four familiar hand gestures can create a compact, adaptive framework for studying voluntary motor access and motor-cognitive control.

The Four Gestures Project is developing open-source tools and proposed protocols built around Squeeze, Spread, Thumbs Up, and Peace. The first proposed framework - The Four Gestures Battery - is designed for research in post-stroke, traumatic brain injury, and other acquired neurological injury populations. It is experimental, unvalidated, and not diagnostic.

THE CENTRAL PROPOSITION

A command such as SQUEEZE is not merely a hand action. It is a stimulus-response trial requiring perception, comprehension, attention, action selection, motor planning, neural transmission, muscle recruitment, visible movement, and timely inhibition or release.

What makes the proposal unusual

- The battery records which gestures are accessible before asking how well they are performed.
- The route adapts to the participant: the battery should branch, not fail.
- The same movements can be placed inside reaction, rhythm, inhibition, choice, switching, memory, and endurance tasks.
- Four measurement levels allow the same task engine to be studied with progressively richer sensing.
- The battery is being built and tested alongside SQUEEZE SYNC, a biofeedback training-game platform for repeated practice.
- Open publication is intended to invite qualified criticism, replication, engineering, and validation - not to bypass them.

The paired development model

THE FOUR GESTURES BATTERY Experimental measurement framework	SQUEEZE SYNC Biofeedback training-game platform
• Standardized cues and routes • Access, timing, consistency, inhibition, switching • Versioned research outputs • Restricted feedback in test conditions	• Repeated guided practice • Immediate biofeedback and engagement • Adjustable pace and session dose • Daily training research in centers and, where appropriate, at home

Measurement and training share the same gestures, cues, timing rules, adaptive pathways, and data structures. That makes SQUEEZE SYNC more than a demonstration: it is a practical way to refine the interaction, study repeatability, and investigate whether daily practice can eventually be made accessible in specialized rehabilitation settings and, where appropriate and formally studied, at home.

Status and intended use

Element	Current status
SQUEEZE SYNC v1	Working prototype with Practice Mode, hardware mode, calibration, guided squeeze-release rhythm, and session/trial logging.
The Four Gestures Battery	Proposed research framework; exact timing, trial counts, thresholds, routes, and stopping rules remain research questions.
Public website	Live at fourgestures.org with project explanation, email signup, contact pathway, and this guide.
Clinical status	No diagnostic, prognostic, treatment-selection, or decision-support claims.
Human research	Only through qualified teams and applicable institutional, ethics, privacy, consent, and safety pathways.

THE ASK

Review the proposed battery. Identify unsafe assumptions and missing confounds. Help define target populations, comparator measures, usability requirements, and validation studies. Positive, negative, and inconclusive findings should all be publishable.

Contents and Reading Paths

This guide is designed for several reading depths. A clinician can read the Five-Minute Clinical Brief and Sections 1-7. A research team can continue through validation, ethics, and the appendices. Engineers can focus on measurement levels, paired development, and the data dictionary.

1. Project Identity and Open-Source Mission

The goal is not to declare a finished medical product. The goal is to publish a testable idea far enough that qualified people can inspect it, challenge it, and carry it forward.

The Four Gestures Project began with a working biofeedback interaction and expanded into a broader research proposition: a small, adaptive gesture battery paired with a repeatable training platform. The public identity is intentionally direct:

CANONICAL PUBLIC IDENTITY

THE FOUR GESTURES PROJECT
OPEN-SOURCE NEUROMOTOR RESEARCH

1.1 Public naming architecture

Name	Role	Public use
The Four Gestures Project	Umbrella research initiative	Website, guide, collaboration, public identity, and project governance.
The Four Gestures Battery	First proposed measurement framework	Clinical and research language for the adaptive battery.
SQUEEZE SYNC	Biofeedback training-game platform	Working prototype, repeated practice, software development, and training research.
fourgestures.org	Public information hub	Project explanation, guide, updates, contact, and future study registry.

1.2 What open source means at this stage

Open-source is a commitment to transparent methods, inspectable assumptions, reproducible task definitions, and staged public release. It is not a claim that every codebase, prototype, or data file is already public. Releases should occur when documentation, licensing, privacy, safety, and versioning are adequate for responsible reuse.

Intended to become openly available	Not promised
Proposed protocols and task definitions	Clinical validity or diagnostic accuracy
Reference software releases and adapters	Safety for every participant or population
Measurement definitions and synthetic examples	Normal ranges or impairment thresholds
Research questions and study templates	Regulatory clearance or institutional endorsement
Version history, limitations, and negative findings	Unrestricted release of identifiable or sensitive data

1.3 Durable project assets

- A concise scientific rationale for beginning with four hand gestures.
- A patient-facing and participant-facing reference application that presents tasks consistently.
- A versioned battery describing cue wording, timing, routes, outcomes, and stopping conditions.
- A hardware-agnostic architecture supporting progressively richer sensing.
- A transparent data dictionary and analysis framework.
- An open research agenda that welcomes revision and failed replication.

2. Clinical and Scientific Rationale

Upper-extremity recovery after acquired neurological injury is multidimensional. Weakness matters, but it is only one part of meaningful performance.

Performance may also depend on movement initiation, selective recruitment, active opening, release control, finger individuation, sensory integration, attention, inhibition, switching, endurance, and the ability to understand and follow instructions. Established measures such as the Fugl-Meyer Assessment and Action Research Arm Test provide indispensable structured observation, while a synchronized digital framework may add trial-level timing and signal information.[1-3]

2.1 Why begin with the hand

The hand is functional, neurologically demanding, easy to cue, and suitable for repeated observation. Squeeze can produce a strong forearm EMG signal. Spread introduces active opening rather than passive cessation. Thumbs Up and Peace require increasing selectivity and finger organization. Research supports treating strength, individuation, dexterity, and proprioception as related but nonidentical dimensions.[4,13-15]

2.2 The movement is the endpoint of an entire neurological process

1	**CUE** What was requested and when?
2	**PERCEIVE + UNDERSTAND** Was the instruction seen, heard, and understood?
3	**SELECT + PLAN** Was the action chosen and organized?
4	**ACTIVATE** When did measurable muscle recruitment begin?
5	**MOVE** What did the hand physically do?
6	**HOLD / RELEASE / SWITCH** Could the response be sustained, terminated, or changed?

No single delay identifies its cause. Visual difficulty, language comprehension, attention, apraxia, reduced central drive, peripheral impairment, pain, joint restriction, fatigue, anxiety, artifact, or misunderstanding can create overlapping outcomes. The proposal gains interpretive value by changing one demand at a time and comparing the pattern across tasks - not by treating one number as anatomically specific.

APPROPRIATE INTERPRETATION

“Response initiation was delayed and variable under choice conditions while activation amplitude remained relatively preserved” is a descriptive finding. “Executive dysfunction caused by a frontal lesion” would be an unsupported diagnostic inference.

2.3 Cognition is inherently part of the task

The same motor response can be embedded in predictable rhythm, simple reaction, choice reaction, Go/No-Go inhibition, switching, delayed imitation, and short sequence memory. Timed motor research in traumatic brain injury suggests that response speed and inhibitory difficulty may persist even when gross recovery appears good. [6,7] The battery therefore studies motor-cognitive performance: cognition expressed through a deliberately simple movement output.

3. The Four Gestures Model

Four gestures are enough because the depth comes from changing the rule around them - not from accumulating dozens of arbitrary hand signs.

SQUEEZE

Gross closing, voluntary activation, holding, endurance, and release.

SPREAD

Active opening, finger separation, reciprocal control, and switching away from flexion.

THUMBS UP

Selective thumb extension and organization while the other digits remain controlled.

PEACE

Selective index-middle extension and separation with suppression of competing movement.

3.1 What each gesture adds

Gesture	Primary movement demand	Why it adds information	Minimum plausible verification
Squeeze	Gross closing and voluntary activation	Initiation, recruitment, hold, endurance, release, and rhythm.	Single-channel forearm EMG for activation; observation or kinematics for exact pose.
Spread	Active opening and finger separation	Reciprocal control, movement away from flexed posture, and switching from closing to opening.	Extensor-oriented EMG plus observation; kinematics for objective separation.
Thumbs Up	Selective thumb extension and positioning	Digit-specific organization while the remaining fingers stay controlled.	Observer confirmation, camera, or motion glove; EMG alone is insufficient for pose truth.
Peace	Index-middle extension and separation	Finger individuation, suppression of competing digits, and differentiated hand shape.	Observer confirmation, camera, or motion glove; ideally synchronized with EMG.

3.2 Release and relax are measured states

Release and relax are not part of the four intentional gesture vocabulary, but they are primary outcomes. The ability to stop a contraction, return toward baseline, and transition out of a gesture can be as informative as the ability to generate it. The framework therefore studies activation and deactivation, initiation and termination, formation and dissolution.

3.3 The Neuromotor Access Profile

The first question is not “What is the total score?” It is “Which gestures are voluntarily accessible today?” With four gestures there are sixteen possible access combinations, including no recognizable gesture. Access should be recorded separately from repeatability, holding, correct selection, and switching.

Gesture	Accessible	Repeatable	Holdable	Selectable	Switchable
Squeeze	Full / partial / absent	Consistency	Hold stability	Correct on cue	Transition cost
Spread	Full / partial / absent	Consistency	Hold stability	Correct on cue	Transition cost
Thumbs Up	Full / partial / absent	Consistency	Hold stability	Correct on cue	Transition cost
Peace	Full / partial / absent	Consistency	Hold stability	Correct on cue	Transition cost

3.4 Access, execution, selection, and switching

Layer	Core question	Example distinction
Access	Can the participant intentionally produce any recognizable version of the gesture?	Detectable attempted activation without visible movement differs from no detected response.
Execution	Can the gesture be formed, held, repeated, and released consistently?	A participant may access Spread but be unable to maintain separation.
Selection	Can the requested gesture be produced while alternatives are suppressed?	All gestures may be possible, yet choice errors may persist.
Switching	Can the participant transition under predictable and unpredictable rules?	Thumbs Up and Peace may be formed individually but not alternated fluently.

THE DEEPER RESULT

The system does not merely produce a score. It describes the participant’s available movement vocabulary - and how accurately, quickly, consistently, and adaptively that vocabulary can be used.

4. Proposed Adaptive Battery

The battery should branch, not fail.

Every participant begins with signal checks, comprehension practice, and a gesture-access screen. Subsequent modules are administered only when their prerequisites are available or when the protocol specifically studies attempted activation. An unavailable gesture is data, not merely a zero and not a reason to invalidate all other measurements.

GESTURE ACCESS CHECK

The battery routes into the tasks that remain meaningful.

SQUEEZE ACCESSIBLE	SQUEEZE + SPREAD	ALL FOUR ACCESSIBLE
Activation pathway	**Reciprocal pathway**	**Selective pathway**
Activation, reaction, release, rhythm, and endurance.	Choice, opposing activation, inhibition, and switching.	Gesture choice, sequencing, individuation, and switching.

4.1 Candidate modular routes

Route	Minimum access	Candidate domains
A. Gross activation	Squeeze	Activation, simple reaction, hold, release, predictable rhythm, Go/No-Go, repeatability, endurance.
B. Reciprocal hand control	Squeeze + Spread	Closing/opening control, transition latency, gross choice response, reciprocal rhythm, switching.
C. Selective formation	Thumbs Up and/or Peace	Configuration, repetition, hold stability, unwanted movement, pose consistency.
D. Selective switching	Both selective gestures	Alternation, random selection, inhibition, switching cost, sequence retention, pace effects.

4.2 Concept battery modules

Module	Participant task	Candidate outputs
0. Setup and calibration	Rest; comfortable activation; posture and signal-quality verification.	Noise floor, usable range, repeatability, quality flags.
1. Gesture access screen	Attempt all four gestures with practice and observer or kinematic confirmation.	Access profile, route eligibility, detectable attempt.
2. Gross activation	Self-initiated squeeze, hold, and release.	Activation capacity, slope, time to peak, hold, release.
3. Reciprocal opening	Spread, hold, relax; alternate Squeeze and Spread where available.	Spread access, reciprocal control, transition timing.
4. Simple reaction and release	Respond to unpredictable Go and Release cues.	Cue-to-onset, release latency, misses, anticipation, variability.
5. Predictable rhythm	Follow slow and standard cadences with an accessible movement pair.	Phase accuracy, drift, entrainment, consistency.

Module	Participant task	Candidate outputs
6. Go/No-Go	Perform an accessible target only for designated cues.	Commission errors, omissions, inhibition, sustained attention.
7. Choice and switching	Choose between two reliably verifiable gestures.	Choice latency, errors, switching cost, perseveration.
8. Selective formation	Form Thumbs Up and/or Peace individually.	Formation accuracy, hold stability, repeatability, unintended movement.
9. Selective alternation	Alternate Thumbs Up and Peace under predictable, randomized, and sequence rules.	Switching latency, rhythm, selection errors, inhibition, sequence retention.
10. Endurance / repeatability	Sustain or repeat an accessible movement.	Performance decay, fatigue sensitivity, recovery, signal-quality changes.
11. Comparison hand	Repeat a matched subset where appropriate.	Within-person asymmetry and bilateral quality differences.

4.3 A signature higher-order task

Alternating Thumbs Up and Peace is visually clear and deceptively demanding. The participant must preserve one configuration, inhibit it, reorganize several digits, produce the alternate configuration, and maintain timing. The module can progress from slow predictable alternation to random choice, No-Go trials, remembered sequences, and rule changes. Exact pose requires observer or kinematic verification; EMG remains useful because it records the muscular attempt and transition beneath the pose.

> **A MEANINGFUL FINDING**
>
> A participant may access all four gestures individually but remain unable to alternate Thumbs Up and Peace. That is not a contradiction. It separates motor availability from higher-order selection and switching.

4.4 Illustrative longitudinal trajectory

Illustrative time point	Gesture access	Higher-order performance
Week 1	Squeeze only	Gross activation route only.
Week 3	Squeeze + partial Spread	Slow reciprocal practice; Spread variable.
Week 5	Squeeze + Spread + emerging Thumbs Up	Choice tasks available; selective gesture not repeatable.
Week 8	All four individually	Unable to alternate Thumbs Up and Peace reliably.
Week 12	All four	Slow alternation successful; errors increase with cadence.

This example does not define expected recovery timing. It demonstrates why an access profile may communicate change more intuitively than a single total score.

5. Measurement Architecture and Information Depth

The framework should never hide its complexity inside a mysterious proprietary score.

A concise summary may help workflow, but the scientifically valuable output is layered: raw signal and kinematics, event timestamps, trial metrics, domain summaries, access profile, and cautious descriptive interpretation.

5.1 Candidate event-level measurements

Metric	Operational definition	Descriptive value
Cue-to-activation latency	Instruction to detected EMG onset.	Complete chain before measurable recruitment; not anatomically specific.
Activation slope	Rate of EMG-envelope rise after onset.	Recruitment speed; not force-development rate without force sensing.
Peak / normalized activation	Maximum or percentile activation relative to calibration.	Voluntary recruitment within the standardized setup.
EMG-to-motion latency	Activation onset to kinematic movement onset.	Activation-to-output relationship when motion sensing is present.
Gesture formation time	Movement onset to valid-pose entry.	Finger organization and execution.
Pose distance / accuracy	Difference between observed and target configuration.	Completeness and selectivity of formation.
Hold stability	Variation during the hold interval.	Control, drift, tremor, fatigue, attention, and signal quality.
Release latency	Release cue to signal or pose dissolution.	Response termination and inhibition.
Return-to-baseline time	Time to rest band or neutral pose.	Relaxation and residual activation.
Rhythm error	Requested versus observed phase timing.	Synchronization and drift.
Commission / omission error	Movement during No-Go or no response during Go.	Inhibition, confusion, anticipation, inability, misunderstanding, or artifact.
Trial variability	Dispersion across comparable trials.	Consistency; often as informative as the mean.
Switching cost	Additional latency or error after a rule or gesture change.	Transition difficulty beyond individual formation time.
Performance decay	Change across sustained or repeated trials.	Endurance, fatigue, attention decline, and learning effects.

5.2 Paired-sensor logic

Layer	Primary question
Cue data	What was requested, under which rule, and at what precise time?
EMG	Was there a muscular attempt? When did activation begin? How did recruitment, holding, release, and coactivation develop?
Contact / pressure	Did the participant reach, touch, press, hold, and release the instrumented object?

Layer	Primary question
Kinematics	What did the hand physically do? Did it reach and maintain the requested configuration? Which digits moved unintentionally?

Together these layers can reveal discrepancies: no activation and no movement; activation without visible movement; contact without correct pose; incomplete or incorrect shape; correct shape with inefficient activation; or prompt, stable movement with reproducible recruitment.

5.3 Candidate domain profile

- Gesture Access
- Gesture Repeatability
- Gesture Selectivity
- Activation Capacity
- Response Speed
- Release Control
- Rhythm Accuracy
- Response Consistency
- Motor Inhibition
- Task Switching
- Activation Endurance
- Right-Left Symmetry
- Cognitive-Load Effect

These dimensions form a session-specific motor-cognitive performance profile. The term profile is intentionally descriptive. It is not a diagnosis, lesion map, or claim that cognition can be isolated from the motor and sensory systems through which it is expressed.

6. Four Measurement Levels

A useful low-cost entry point and a clear path to richer measurement can preserve one protocol while making each sensor boundary explicit.

LEVEL 1

SINGLE-CHANNEL FOREARM EMG

Accessible entry level

Activation onset, relative amplitude, hold, release, rhythm, repetition.

LEVEL 2

DUAL-CHANNEL FOREARM EMG

Reciprocal recruitment

Flexor-extensor comparison, co-contraction, transition timing, classification research.

LEVEL 3

HAND BOX + EMG

Instrumented interaction

Contact, pressure, placement, grip-release timing, standardized physical geometry.

LEVEL 4

MOTION-CAPTURE GLOVE + EMG

Activation + kinematics

Pose verification, trajectories, individuation, formation, hold, release, switching.

6.1 What each level can and cannot support

Level	Adds	Potential measures	Boundary
1. Single-channel EMG	One forearm activation channel	Onset, relative amplitude, hold, release, rhythm, repetition.	Does not identify exact pose or literal grip strength.
2. Dual-channel EMG	Complementary forearm activity	Reciprocal recruitment, co-contraction, transition timing, classification research.	Exact Thumbs Up and Peace geometry remains unverified.
3. Hand Box + EMG	Standardized physical contact and pressure	Contact events, pressure, hand placement, grip-release timing.	Instrument geometry and force sensing require technical validation.
4. Motion glove + EMG	Finger and joint kinematics	Pose verification, trajectories, individuation, formation, hold, release, switching.	Each glove, calibration method, and algorithm requires independent validation.

6.2 Simplest practical research setup

Component	Minimum demonstrator	Research expansion
Computer	Laptop or desktop running SQUEEZE SYNC.	Timestamp synchronization, replay, protocol locking, analysis export.
EMG	One supported channel.	Two synchronized channels with documented placement.
Movement verification	Observer confirmation or Practice Mode.	Hand Box, glove, or validated camera-based pose source.
Positioning	Illustrated seated posture and forearm support.	Standardized jig, measurements, or documented positioning protocol.

Component	Minimum demonstrator	Research expansion
Data storage	Local CSV/JSON with study ID.	Institution-managed secure storage and approved de-identified datasets.
Workflow	Calibrate, practice, administer, export.	Quality checks, audit trail, multisite metadata, version control.

DESIGN RULE

The software must never infer more than the connected sensors can support. Every exported result should identify the measurement level, hardware, verification method, software version, and protocol version used.

7. The Battery and SQUEEZE SYNC, Built Together

The project is developing measurement and training concurrently rather than treating rehabilitation practice as an afterthought.

THE FOUR GESTURES BATTERY Experimental measurement framework	SQUEEZE SYNC Biofeedback training-game platform
• Standardized cues and routes • Access, timing, consistency, inhibition, switching • Versioned research outputs • Restricted feedback in test conditions	• Repeated guided practice • Immediate biofeedback and engagement • Adjustable pace and session dose • Daily training research in centers and, where appropriate, at home

7.1 Why concurrent development matters

Gameplay reveals whether cues are understandable, calibration works, pacing is tolerable, transitions are naturally difficult, and data are reliably produced. The battery can be extracted from a working interaction rather than imposed on a fragile prototype. At the same time, a version-controlled battery can prevent the training platform from drifting into unmeasured claims.

- Shared gestures create a common language between assessment research and repeated practice.
- Shared timing and event definitions make training sessions potential sources of technical and usability data when used under approved research protocols.
- Adaptive routes can make practice meaningful even when selective gestures are not yet accessible.
- Frequent repetitions can reveal learning, fatigue, day-to-day variability, and sensor limitations that a single session may miss.
- Open methods can support replication across homes, clinics, rehabilitation centers, and engineering laboratories - only after the relevant safety, privacy, and validation requirements are defined.

7.2 The research loop

Step	Question
1. Build a playable interaction	Can participants understand and complete the cue-response cycle?
2. Verify engineering	Are timing, calibration, logging, and signal quality reliable?
3. Freeze a proposed protocol	Which settings must remain fixed for comparable research sessions?
4. Study usability and reliability	Can participants and clinicians repeat the workflow consistently?
5. Compare with established measures	What does each metric relate to, and what does it add?
6. Refine training and battery together	Which cues, doses, feedback, and routes remain useful without overclaiming?

7.3 Game mode versus research test mode

Training / Game Mode	Research Test Mode
Immediate encouraging feedback	Feedback visibility fixed by protocol
Adjustable cadence and session length	Version-locked cue timing and trial counts
Streaks, pacing, and engagement	Domain metrics, access profile, and quality flags
High repetition	Controlled trials and planned rest
User-selected difficulty	Eligibility and branching rules
Can optimize motivation	Must preserve measurement comparability

The same engine may support both modes, but claims and configuration must remain distinct. A session export should identify whether it occurred in Game, Practice, Demonstration, or Research Test Mode.

7.4 SQUEEZE SYNC roadmap

Version	Playable scope	Research value
v1 - Squeeze / Release	Practice and hardware modes, calibration, guided rhythm, immediate feedback, and session/trial logging.	Establishes the interaction and repeated stimulus-response engine.
v2 - Spread dynamics	Adds Spread / Relax and Squeeze-Spread reciprocal transitions.	Creates a closing-opening control pathway and broader training vocabulary.
v3 - Selective gestures	Adds Thumbs Up and Peace modules with observer or kinematic verification.	Introduces finger-specific organization, selection, inhibition, sequencing, and switching.
Battery Mode v0.1	Fixed cues, trial counts, quality flags, adaptive routing, versioned export, and controlled feedback.	Transforms game primitives into a reproducible proposed protocol.

ACCESS GOAL

Rehabilitation is difficult and motivation can be sparse. The long-term research goal is not only to measure performance, but to investigate whether repeated, understandable, accessible practice can be supported in specialized rehabilitation settings and, where appropriate and formally studied, at home.

8. Clinician-Facing Reporting

A useful report should be understandable in seconds but auditable in depth.

8.1 Recommended reporting sequence

1. Quality: Was calibration usable? Were artifacts, interruptions, pain, or protocol deviations recorded?
2. Access: Which gestures were full, partial, absent, or attempted with detectable activation?
3. Execution: Could each accessible gesture be formed, repeated, held, and released?
4. Selection: Could the requested gesture be produced while alternatives were suppressed?
5. Switching: Could the participant transition under predictable and unpredictable rules?
6. Longitudinal change: Did a new gesture emerge, or did an accessible gesture become faster, more stable, more selective, or more switchable?

8.2 Example access matrix

Gesture	Access	Repeatability	Hold	Selection	Switching
Squeeze	Full	Consistent	Stable	Accurate	Available
Spread	Full	Variable	Unstable	Accurate	Delayed
Thumbs Up	Partial	Not repeatable	Not tested	Variable	Not tested
Peace	Absent	-	-	-	-

8.3 Example interpretive language

ILLUSTRATIVE REPORT - NOT A CLINICAL CONCLUSION

The session was technically usable after one repeated calibration. Gross squeeze activation was accessible and repeatable. Spread was accessible but variable, with delayed transitions from Squeeze. Thumbs Up was partially formed and not repeatable. Peace was not accessible under the tested conditions. Simple response latency was slower and more variable on the tested side than on the comparison side. These findings describe performance in the administered protocol and do not identify the cause or location of impairment.

8.4 What not to report

Avoid	Use instead
“The participant failed the battery.”	“The participant completed the Gross Activation and Reciprocal routes; selective-gesture routes were unavailable.”
“Executive dysfunction detected.”	“Choice and switching conditions produced greater latency and error than simple response conditions.”
“Grip strength was low.”	“Normalized EMG activation was low under this setup”; use a force sensor for strength claims.

Avoid	Use instead
“Stroke impairment score.”	“Four Gestures performance profile, protocol version X, measurement level Y.”
“Normal / abnormal” without norms.	Report raw values, within-person comparison, reliability limits, and study-defined thresholds only after validation.

9. Validation and Research Program

Open publication should accelerate scrutiny, not shortcut validation.

The proper sequence is to build the interaction, verify the engineering, create a draft protocol, study usability and reliability, compare with established measures, and then determine whether the outputs are meaningful.

Stage	Purpose
1. Engineering prototype	Reliable acquisition, calibration, cue timestamps, event logging, replay, and quality visualization.
2. Technical verification	Filtering latency, sample timing, synchronization, data integrity, classifier accuracy, and reproducible exports.
3. Human-factors feasibility	Setup time, comfort, comprehension, completion, signal quality, and clinician workflow.
4. Healthy reference research	Test-retest reliability; age, handedness, posture, fatigue, and learning effects; minimal detectable change.
5. Clinical pilot	Feasibility across impairment levels and comparison with established motor, dexterity, strength, and cognitive measures.
6. Construct validation	Determine which metrics correlate with known constructs and which provide independent information.
7. Responsiveness study	Examine whether metrics change during rehabilitation beyond measurement error.
8. Battery refinement	Remove redundant tasks; define stopping rules; optimize duration; preregister algorithms; lock protocol versions.
9. Multisite validation	Inter-site reproducibility, operator effects, hardware variation, language, and demographic generalizability.
10. Intended-use strategy	Only after evidence exists: define claims, risk, regulatory pathway, quality management, cybersecurity, and implementation.

9.1 High-value early research questions

- Can cue-to-EMG onset be measured reliably with an inexpensive single-channel setup?
- Does release latency provide information beyond activation latency and force or pressure measures?
- How reliable is the four-gesture access screen across observers and sessions?
- Does dual-channel EMG add meaningful reciprocal-control information beyond Level 1?
- Can a Hand Box add reliable contact and pressure timing without overcomplicating setup?
- How accurately does a motion glove identify the four poses across restricted range, tremor, edema, contracture, and spasticity?
- Can attempted activation be detected when no visible gesture occurs?
- Does the difference between simple, choice, and No-Go conditions correlate with established cognitive or reaction-time measures?
- Can switching cost between Thumbs Up and Peace be separated from individual formation time?
- Which metrics are responsive to occupational or physical therapy, and which mainly reflect learning, fatigue, or sensor repositioning?
- Can a short battery preserve most of the useful information in a longer research protocol?
- Which findings replicate across institutions and hardware configurations?

9.2 Public validation registry

The website may eventually maintain a registry of proposed, preregistered, recruiting, completed, and published studies. Each listing should identify institution, country, population, measurement level, protocol version, study status, registration link, and results link. Negative and inconclusive findings should remain visible.

10. Ethics, Privacy, Safety, and Regulatory Boundaries

CORE BOUNDARY

The Four Gestures Battery does not diagnose stroke, traumatic brain injury, neurological injury, cognitive impairment, or any other condition. It does not identify lesion location, replace imaging, replace neurological or neuropsychological examination, or determine treatment. It is an experimental measurement framework whose claims must remain narrow until evidence and appropriate review support anything broader.

10.1 Human-subject research

Research involving patients, vulnerable populations, or identifiable private information may require institutional review, informed consent, and ongoing oversight. The public project should never instruct unqualified visitors to conduct informal patient experiments.[17,18]

10.2 Data and privacy

Early public software should favor local storage, study IDs rather than names, and no automatic cloud upload. Institutions remain responsible for privacy, security, consent, de-identification, retention, and data-use requirements. Removing a name alone is not necessarily sufficient de-identification.[24]

10.3 Intended use and software claims

Intended use, disease or condition claims, and target population matter when determining whether software is intended for a medical purpose. Open-source status and disclaimers do not automatically remove regulatory considerations if software is promoted for diagnosis, treatment selection, or clinical decision-making.[16,25]

10.4 Safety and accessibility safeguards

- Clear stopping rules for pain, distress, excessive fatigue, skin irritation, or unsafe compensatory movement.
- Practice trials to separate misunderstanding from performance limitation.
- Large, high-contrast visual cues and optional auditory reinforcement.
- Validated translation and comprehension procedures rather than improvised instructions.
- Documentation of posture, support, range restrictions, sensory loss, pain, and assistive devices.
- Comfortable calibration rather than maximal contraction as the default early pathway.
- Cleaning and infection-control procedures for shared electrodes, boxes, and gloves.
- No punitive interface language; feedback represents task matching, not personal failure.

10.5 Institutional representation

The project should be presented as an independent open research concept unless an institution formally agrees otherwise. Employer time, equipment, patient access, branding, confidential workflows, and intellectual-property obligations require institution-specific review. No hospital or university logo should imply endorsement without authorization.

11. Contribution, Governance, and Staged Openness

The project needs a canonical protocol and accountable stewardship, not a mystery score or a controlling black box.

11.1 Contribution paths

Contributor	High-value contribution
Clinicians and rehabilitation professionals	Identify unsafe assumptions, workflow barriers, confounds, and outcomes that would or would not be clinically meaningful.
Researchers	Challenge constructs, propose studies, define comparators, and distinguish descriptive metrics from validated outcomes.
Engineers and developers	Improve sensing, synchronization, calibration, signal quality, hardware adapters, accessibility, and reproducibility.
Patients and people with lived experience	Review burden, dignity, fatigue, consent, accessibility, language, and whether the interaction feels supportive.
Advocates and accessibility reviewers	Examine inclusion, motor access, cognitive load, privacy, and social consequences of measurement.
Supporters and institutions	Connect the project with qualified collaborators, facilities, equipment, review pathways, and responsible funding.

11.2 Suggested roles

Role	Purpose
Originator and founding steward	Maintains mission, public narrative, initial software, canonical history, and release coordination.
Technical maintainers	Review code, adapters, releases, tests, security reports, and data-schema changes.
Clinical advisory group	Identifies unsafe assumptions, accessibility issues, confounds, comparators, and meaningful outcomes.
Protocol working group	Reviews timing, routing, stopping rules, scoring, and proposed revisions.
Research registry editors	Verify study links, protocol versions, measurement levels, and publication status.
Community contributors	Submit critiques, translations, adapters, analysis code, study proposals, and documentation.

11.3 Canonical protocol rules

- Every release receives a version number and changelog.
- Modified versions identify themselves as modified.
- Scoring algorithms are frozen or preregistered before confirmatory analysis.
- Claims identify the population, measurement level, protocol version, and study context.
- Unavailable gestures are preserved as data rather than imputed as ordinary failed trials.

- Core changes require a public rationale and appropriate advisory review.
- No result is labeled validated without identifying exactly what was validated.

11.4 Licensing direction

The intended licensing objective is broad reuse with attribution and a durable scholarly record. Software, documentation, diagrams, synthetic data, real research data, and project marks may require different licenses or policies. Final licensing should be staged and reviewed before public release, especially where contributors, employer-related rights, patents, or sensitive data are involved.[19,20]

12. Current Status and Development Roadmap

The project is public enough to invite qualified attention, but early enough that nearly every technical and clinical claim remains open to testing.

12.1 What exists now

Asset	Status
fourgestures.org	Live public landing page explaining the mission, battery, measurement levels, SQUEEZE SYNC, contribution pathways, and clinical disclaimer.
SQUEEZE SYNC v1	Working Python prototype with Practice Mode and supported EMG workflow, guided squeeze-release rhythm, calibration, feedback, and logging.
Project Guide v1	Public concept and research roadmap consolidating the first proposed framework.
Canonical identity	The Four Gestures Project - Open-Source Neuromotor Research - Squeeze, Spread, Thumbs Up, Peace.

12.2 What remains to be built

Software	Hardware	Research
Spread, Thumbs Up, and Peace modules; adaptive routing; observer-confirmed pose workflow; standardized exports; accessibility and fatigue controls.	Dual-channel workflow; Hand Box prototype; glove adapter; sensor synchronization; placement and calibration documentation.	Feasibility; technical reliability; test-retest reliability; inter-rater agreement; construct validity; comparator studies; responsiveness; usability; confounds; stopping rules.

12.3 Near-term sequence

7. Document and hardware-test SQUEEZE SYNC v1 thresholds and data outputs.
8. Build Spread and reciprocal Squeeze-Spread training modes.
9. Draft the first fixed Battery Mode protocol and quality flags.
10. Develop Level 2 dual-channel workflow and repeatable placement documentation.
11. Prototype the Hand Box as a standardized Level 3 interaction.
12. Add selective gesture verification through observer input and later kinematics.
13. Invite clinician, researcher, engineer, patient, and advocate review before human studies.
14. Pursue feasibility and reliability research through appropriate institutional pathways.

PUBLIC STATUS STATEMENT

Here is the idea. Here is the working interaction. Here is the proposed framework. We do not yet know whether it is clinically valid. The next step is qualified review, careful engineering, and formal study.

Conclusion and Open Invitation

The Four Gestures Project is not being offered as a finished clinical instrument. It is being offered as a serious question the world can test.

Squeeze represents gross voluntary activation. Spread represents reciprocal opening. Thumbs Up represents selective thumb organization. Peace represents differentiated finger control. Around these gestures, the proposed battery studies access, execution, selection, inhibition, rhythm, endurance, and switching. Alongside it, SQUEEZE SYNC explores how the same movement language can support repeated, motivating biofeedback practice.

The most important contribution may be methodological: build measurement and training together; make every sensor boundary visible; preserve unavailable gestures as data; expose the assumptions; and invite replication before making clinical claims.

OPEN INVITATION

Clinicians, rehabilitation professionals, researchers, engineers, people with lived experience, advocates, institutions, and supporters are invited to review the framework, identify its weaknesses, and help determine what - if anything - is reliable, valid, useful, safe, and worth carrying forward.

fourgestures.org

Appendix A. Concept Battery Specification

This specification is a research-planning draft, not a validated protocol. Exact durations, trial counts, classifier thresholds, rest periods, cue modalities, eligibility rules, and stopping conditions remain research questions.

Component	Draft dose	Task structure	Candidate outputs
Signal check	20-30 s	Rest; two comfortable activations; posture and signal-quality review.	Noise floor, usable amplitude, clipping, artifact, calibration stability.
Gesture access screen	1-2 attempts each	Attempt Squeeze, Spread, Thumbs Up, and Peace.	Full / partial / absent access; observer confidence; detectable attempt.
Self-initiated Squeeze	3 trials	Squeeze when ready; hold 2 s; release.	Peak, slope, time to peak, hold, release profile.
Spread / relax	3 trials	Only when accessible or attempted activation is a study target.	Spread onset, hold, relaxation, verification confidence.
Simple reaction	8-12 trials	Variable foreperiod; one accessible target.	Reaction latency, anticipation, misses, variability.
Release reaction	6-8 trials	Hold an accessible gesture; variable Release cue.	Release onset, return to baseline, residual activation.
Rhythm	6-8 cycles	Slow then standard cadence.	Timing error, phase accuracy, drift.
Go/No-Go	16-24 trials	Accessible target; randomized No-Go cue.	Commission / omission errors and latency distribution.
Choice / switching	12-20 trials	Two reliably verifiable gestures.	Choice latency, errors, switching cost, perseveration.
Thumbs Up / Peace	8-16 transitions	Both gestures accessible; predictable then randomized.	Formation and switching time, rhythm, sequence and inhibition errors.
Endurance / repeatability	Protocol-specific	Sustained or repeated accessible gesture.	Decline, variability, recovery, quality flags.
Comparison hand	Selected modules	Repeat matched subset where appropriate.	Within-person asymmetry.

Appendix B. Minimum Data Dictionary

Field	Definition	Type
project_id	Public project or study identifier	Text
session_id	Random or institution-defined session identifier	Text
participant_code	Non-name study code	Text
software_version	SQUEEZE SYNC release	Semantic version
protocol_version	Four Gestures Battery protocol release	Semantic version
algorithm_version	Signal / pose processing version	Text
measurement_level	1, 2, 3, or 4	Integer
emg_device	Model and firmware	Text
emg_sample_rate_hz	Recorded sampling rate	Number
emg_channels	Channel count and labels	Structured text
electrode_placement	Standardized placement code plus notes	Text
contact_source	None / Hand Box / other instrument	Enum
pose_source	Observer / practice / glove / camera	Enum
pose_device	Model and firmware where present	Text
hand_tested	Left or right	Enum
dominance	Left / right / mixed / unknown	Enum
protocol_deviations	Pauses, repeats, altered pace, overrides	Text
cue_event	Cue type and timestamp	Event table
emg_onset	Detected onset timestamp and confidence	Event table
movement_onset	Kinematic or contact onset where available	Event table
valid_pose_entry	Pose-region entry and confidence	Event table
release_event	Release cue and observed termination	Event table
trial_quality	Usable / artifact / interrupted / excluded	Enum
gesture_access	Full / partial / absent / attempted	Enum
raw_data_location	Local or approved institutional path	URI / path
consent_and_approval	Institution-managed reference, not participant identity	Text

Appendix C. Sample Clinician-Facing Report

EXAMPLE ONLY

This fictional output demonstrates report structure and language. It is not a validated interpretation, reference range, or recommendation.

Section	Illustrative output
Session quality	Usable after one repeated calibration. One motion-artifact trial excluded.
Measurement level / protocol	Level 2 dual EMG; Protocol v0.1; Software v0.3.
Gesture access	Squeeze and Spread accessible. Thumbs Up partial and not repeatable. Peace unavailable.
Activation capacity	Squeeze activation relatively preserved and consistent within session.
Response speed	Simple response slower and more variable on tested side than comparison side.
Release control	Release onset delayed; return to baseline prolonged but repeatable.
Rhythm	Accurate at slow Squeeze-Release cadence; drift increased at standard cadence.
Switching	Squeeze-Spread transitions delayed. Selective-gesture switching not administered.
Descriptive summary	Preserved gross activation with accessible reciprocal opening, delayed response and release timing, and limited selective-gesture access. Findings are protocol-specific and non-diagnostic.

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