ISresearcher.com

EEG Experiment SOP — From Zero to Done (RAP Lab)

Standard operating procedure for running EEG experiments with the gel cap + CytonDaisy (+ BIOPAC ring). Start at Step 0 and go in order.

Version	Date	Changes
1.0	2026-09-27	First version
2.0	2026-09-27	Added: system setup and synchronization (new Step 4), analysis plan, eligibility and data-exclusion rules, behavioral measures, deception and adverse-event handling, 60 Hz notch, electrical safety, robot noise check, hair guidance, cap disinfection, data naming, troubleshooting and templates

Items marked **[fill in]** are lab- or study-specific and must be completed before use.

Step 0: The question — before you touch anything

Write one sentence: **"I am testing whether X changes Y."**

Example: "I am testing whether a conversational robot apology (vs. a scripted one) produces a faster return to approach-motivation brain activity after a trust violation."

Then write a second sentence naming **the exact measure** you'll use for Y:

Example: "Y = frontal alpha asymmetry (F4 minus F3 log alpha power, 8–13 Hz) in the 60 seconds after the apology, relative to resting baseline."

Everything downstream — design, channels, analysis — depends on these two sentences. If you can't write them, you're not ready for Step 1.

Step 1: Ethics — before any human data

- **MREB approval is required** before collecting data that will become a study. Start the application early; it takes weeks.
- Equipment testing with lab volunteers (pilot work) still gets **informed consent**: what you're doing, that they can stop anytime, how data is stored.
- Prepare a **debrief form** explaining the study's purpose afterward.
- **Deception:** if any part of the study is staged (e.g., the robot "fails" on purpose to create a trust violation), that is deception. The MREB application must justify it, and the debrief must reveal it (see Step 11).

- **Recruitment and compensation:** describe how participants are found, what they're told in advance, and what they're paid. MREB will ask.
- **Adverse events:** state in the application what happens if a participant becomes unwell or distressed (see Appendix C).
- **Data storage:** participant/sensitive data goes on **MacDrive** (per lab rules), never personal laptops or cloud drives. Request access via the service desk if you don't have it.
- **Identity protection:** each participant gets an ID code (e.g., P001). The list linking names to IDs is stored separately from the data, with restricted access.
- **Retention:** record how long data is kept and how it is destroyed, as approved by MREB. **[fill in]**

Step 2: Design the experiment

Core design

- **Within-subject:** every participant does every condition. Each person is their own control — far more statistical power than between-subject designs.
- **Counterbalance** condition order across participants (half get A-then-B, half B-then-A) to cancel order effects.
- **Enough trials:** event-related signals (e.g., P300) need **20–30+ clean trials per condition** to emerge from noise. One trial per participant is not an experiment. Plan extra trials, since some will be rejected for artifacts.
- **Control condition:** every comparison needs a baseline to be compared against (resting baseline at minimum).
- **Sample size:** decide upfront, roughly, from a power argument — not "as many as show up."

Know the hardware limits

- With the Daisy attached and streaming over the Bluetooth dongle, the Cyton records at about **125 samples per second per channel**. That's fine for alpha, theta, beta, and P300 work. It is **not** enough for high-frequency (gamma) analysis. Don't design a study the hardware can't support.
- Session length: capping alone usually takes 30–45 minutes. Keep total session time realistic — tired participants produce worse data in later blocks. Expected total: **[fill in]** minutes.

Behavioral and self-report measures

EEG alone rarely answers the question. Plan:

- A **manipulation check**: did participants actually experience what you intended (e.g., did they perceive a trust violation)?
- **Validated questionnaires** where relevant (e.g., trust scales before and after). **[fill in]**
- Where each measure goes in the session, and how long it takes.

Eligibility rules (who can take part)

Decide before recruiting. Examples — adjust for the study:

- No history of seizures or epilepsy (especially if any stimulus flashes)

- No open wounds, sores, or active skin conditions on the scalp
- No known allergy to electrode gel
- Handedness requirement, if the measure depends on brain asymmetry
- Age range: **[fill in]**
- Other: **[fill in]**

Data-exclusion rules (whose data gets dropped)

Also decide before collecting. Examples:

- Fewer than **[fill in, e.g., 20]** clean trials in any condition
- More than **[fill in, e.g., 5%]** of data packets lost
- Failed the manipulation check
- Session interrupted beyond recovery

Analysis plan — write it now, not after the data

Decide and write down every processing step before the first real participant. Changing these after seeing the data lets the results be tuned, even by accident. Ideally, preregister the plan (e.g., on OSF).

- Filters: high-pass **[fill in]** Hz, low-pass **[fill in]** Hz, notch at **60 Hz** (Canadian mains)
- Re-referencing: **[fill in]** (e.g., average reference, linked mastoids)
- Artifact removal: **[fill in]** (e.g., ICA for eye blinks, amplitude threshold for rejection at ±**[fill in]** μV)
- Epochs: **[fill in]** (time window around each event)
- Outcome measure and statistical test: **[fill in]**
- Software and version: **[fill in]** (e.g., MNE-Python, EEGLAB)

Step 3: Write the protocol script

- The **exact words** you'll say to every participant, the exact task order, exact block timing, exact break placement, and when each questionnaire is given.
- If you improvise instructions per person, you've baked inconsistency into your data. Read from the script.

Step 4: System setup and synchronization — before piloting

This step makes sure every device's data can be lined up on one timeline. Without it, you can't say "the brain did X when the robot did Y."

4.1 The problem in plain terms

You have up to three separate clocks:

1. The **stimulus / robot computer** (knows when events happened)
2. The **OpenBCI** stream (EEG)
3. The **BIOPAC ring** (physiological signal)

Each keeps its own time. Left alone, they drift apart and have unknown delays between them.

4.2 Stimulus and robot control software

- Name the software that presents stimuli and cues the robot: **[fill in]** (e.g., PsychoPy, a Wizard-of-Oz control panel).
- It must write its own **timestamped log** of every event (stimulus shown, robot action, participant response).
- It must also **send a marker** for each event into the recording (see 4.3).

4.3 Getting event markers into the data — pick one method

Option A: Lab Streaming Layer (LSL) — recommended starting point. LSL is free software that lets several devices stream data to one recorder, which stamps everything with a shared clock.

- OpenBCI GUI: stream EEG to LSL using the **Networking widget**.
- Stimulus software: send event markers as an LSL stream (PsychoPy can do this via `pylsl`).
- Record all streams together with **LabRecorder**, which saves one `.xdf` file containing everything.
- BIOPAC ring: if its software can stream to LSL, add it. If not, record it separately and use sync events (4.4).

Option B: Hardware trigger. The stimulus computer sends an electrical pulse into the Cyton's digital input pins, which is recorded alongside the EEG. More precise timing, but needs wiring and a compatible output device. See OpenBCI documentation on external triggers before attempting.

Chosen method for this study: **[fill in]**

4.4 Aligning the BIOPAC ring

If the ring can't join the shared stream, create **sync events** that show up in both recordings — at the start and the end of every session. Use the two points to correct for drift between them. Method: **[fill in]**

4.5 Timing test (do once, repeat if anything changes)

Measure the actual delay between "event happened" and "marker recorded":

- Put a light sensor (photodiode) on the screen corner where a white square flashes with each stimulus, and record its signal alongside the markers.
- Compare the marker time to the moment the light actually appeared.
- Record the average delay and how much it varies (jitter). Bluetooth adds both.
- If jitter is more than about **[fill in, e.g., 10]** ms, consider the hardware trigger option for event-related analyses.

Result: average delay **[fill in]** ms, jitter **[fill in]** ms, tested on **[date]**.

4.6 Montage map and GUI settings

Fill in Appendix B: which board pin connects to which scalp site (10-20 system). Keep a printed copy with the kit.

GUI settings to confirm and write down:

- Channels: **16** (Cyton + Daisy)
- Reference: SRB2 **ON** for all 16 channels, with the REF ear clip ganged to both boards' SRB pins via the Y-splitter. Both boards must match.
- Bias: included for all channels
- Notch filter: **60 Hz**
- Other: **[fill in]**

4.7 Robot noise check

Robot motors and electronics can add electrical noise to the EEG.

- With the cap on, record 2 minutes with the robot off, then 2 minutes with the robot running at its normal distance and doing its normal movements.
- Compare. If the robot adds noise, increase the distance until it doesn't.
- Minimum robot-to-cap distance: **[fill in]** m.

Step 5: Pilot on yourself

- Run the entire protocol solo, cap on, exactly as a participant would experience it.
- The pilot answers:
- Does the timing work?
- Are instructions clear?
- Does the data look sane?
- Do markers appear at the right moments?
- Is packet loss acceptable?
- Does the full analysis pipeline run start to finish on the pilot file?
- Fix everything here, not with participant #1 in the chair.

Step 6: Equipment prep — the day before

☐ Cyton + Daisy batteries charged; BIOPAC ring charged and paired
☐ Enough electrode gel; syringe clean (blunt tip)
☐ Right cap sizes available; caps cleaned **and disinfected** from last use
☐ HPTA cables intact; Y-splitter present
☐ Laptop charged; OpenBCI GUI launches; dongle found in a test stream
☐ Stimulus/robot software launches; marker test works (LSL streams visible in LabRecorder, or trigger pulses appear)
☐ Hair clips, towels, tissues, comb available
☐ Consent + debrief forms printed; questionnaires ready; metadata log sheet ready (Appendix D)
☐ Troubleshooting sheet (Appendix A) and montage map (Appendix B) with the kit

Step 7: Room prep — session day, before the participant arrives

- Quiet room, away from humming equipment and power cables
- Participant's phone: **off or airplane mode, across the room** (cellular bursts = spike artifacts)
- Your communication phone/tablet (if used): airplane mode + WiFi, or kept 2+ meters from the cap
- **Electrical safety:** the Cyton + Daisy run on **battery only** while connected to a person — never plugged into a wall charger or powered from a wall-connected device.
- Laptop on battery if possible (reduces mains hum)
- Robot positioned at or beyond the minimum distance (Step 4.7)
- Chair: comfortable, back supported, feet flat
- GUI open, session name set, **16 channels selected**, **60 Hz notch on**, widgets ready (Time Series, Impedance, Band Power)
- Recording chain ready: LSL streams running and visible in LabRecorder (or trigger path tested)

Step 8: Participant welcome

- Greet, explain the session in plain language, **sign consent**
- Confirm eligibility (Step 2 rules). If someone isn't eligible, thank them, explain kindly, and pay per the approved protocol.
- Screening questions — log the answers:
- Caffeine in the last few hours? (affects arousal/alpha)
- Sleep last night? (drowsiness shows in the data)
- Hair products? (heavy product wrecks electrode contact)
- Any allergies, especially to gels or skin products?
- Any relevant medications or neurological history?
- Handedness (if relevant)
- Bathroom break. Offer water. Make them comfortable — comfort is data quality.

Step 9: Capping

1. **Check the scalp:** look for cuts, sores, or irritation where electrodes will sit. If present, don't place gel there; note it, and consult the eligibility rules.
2. **Landmarks:** find nasion (dip between eyes) and inion (bony bump, back of skull). Measure nasion–inion distance; mark the 10% point with a wax crayon. (See Tech3Lab landmark video notes.)
3. **Cap size & placement:** choose the size, center the cap — Cz at the crown. A rotated cap mislabels every electrode downstream.
4. **Hair:** gel caps take longer with thick, curly, coily, or braided hair. Allow extra time and don't rush. - Use the blunt syringe tip to gently part hair under each electrode before adding gel, so gel reaches the scalp. - Use clips to hold hair away from the electrode where needed. - For braids or protective styles, work with the participant — ask what's comfortable. Many electrode sites can be reached between braids. - Recruitment materials should mention what the cap involves, so participants can plan their hair around the session.
5. **Gel:** inject a small amount at each electrode with the syringe. Too much gel can bridge neighboring electrodes and blur their signals together.

6. **Reference & ground:** REF clip to earlobe/mastoid (via Y-splitter to ganged SRB pins); BIAS to mastoid GND.
7. **Impedance check:** all green (<10–20 kΩ). Reseat and re-gel any red channel. **Never start recording on a red channel.** (The impedance check sends a tiny test current — run it before recording, not during.)
8. **Settle:** wait 3–5 minutes. Gel needs a moment; the participant needs a moment.
9. **BIOPAC ring:** on the finger, snug fit, confirm the signal reads.

Step 10: Recording

1. **Start all recordings, then send a sync event** (Step 4.4) so every file shares a starting point.
2. **Baseline first, always:** 1–2 min eyes open (fixation point), 1–2 min eyes closed. Everything later is interpreted against this. Mark the start and end of each.
3. **Instruct from the script:** "Sit still, relax your jaw and shoulders, blink normally — don't try not to blink."
4. **Run the blocks.** Between blocks, step in: check impedances, ask how they're doing, offer a stretch.
5. **Mark every event** — condition changes, stimuli, robot actions, interruptions. Markers should come automatically from the stimulus software; add manual notes for anything unplanned. Memory lies, markers don't.
6. **Monitor live:** glance at the Time Series between trials. A channel drifting or railing = pause and fix now, not tomorrow. Watch for packet-loss warnings.
7. **Give questionnaires** at the scripted points.
8. **Communicate:** on-screen text prompts for instructions (standardized); intercom/video call for check-ins; pre-agreed summon signal (call bell / call your name) so they can reach you anytime.
9. **Watch the person, not just the data.** If they seem distressed or unwell, stop and follow Appendix C.
10. **End sync event** before stopping the recordings.

Step 11: Wrap-up — before they leave

- **Verify the data while they're still in the room:** do the expected signatures show up (alpha blocking when eyes close? blink spikes at Fp1/Fp2?)? Are markers present? If something's wrong, you can re-run now.
- Stop the session; confirm **all** files saved (EEG, markers, BIOPAC, stimulus log, questionnaires).
- Remove the cap; hand them a towel/tissues for the gel (it washes out with shampoo — reassure them).
- **Debrief:** explain the study's purpose, answer questions, thank them.
- **If deception was used:** explain clearly what was staged (e.g., the robot's mistake was scripted, not a real malfunction) and why it was needed. Check how they feel about it. Offer the option to **withdraw their data** now that they know, per the approved protocol.
- Pay compensation and record it.

Step 12: After the session

☐ Name files by the lab convention: `[StudyCode]_[ParticipantID]_[YYYY-MM-DD]_[datatype]` (e.g., `APOL_P007_2026-10-14_eeg.xdf`) **[confirm or fill in]**
☐ Copy data to **two** locations (one being MacDrive for participant data)
☐ Fill the metadata log immediately (Appendix D): participant ID, date, cap size, impedance values, condition order, screening answers, packet loss, anything unusual ("fire alarm at 14:32")
☐ Clean the cap: warm water rinse ~15 min, cotton ball for residue
☐ **Disinfect the cap** following the manufacturer's instructions (a rinse cleans but does not disinfect), then hang dry away from sunlight
☐ Wipe down the ear clips, ring, and chair
☐ Run the quality check within 24 hours: clean-trial count per condition, compared to the exclusion rules
☐ Note anything to fix in the protocol before the next participant. If the SOP changes, update the version table at the top.

Appendix A: Troubleshooting

Problem	What it looks like	Try this
Railed channel	Flat line stuck at the top or bottom of the plot	Reseat electrode, add a little gel, check cable connection
Heavy 60 Hz noise	Thick, fuzzy band on many channels	Confirm notch is 60 Hz; move away from power cables; laptop on battery; check REF and BIAS clips
One noisy channel	Single channel much messier than neighbors	Check impedance on that channel; part hair and re-gel
All channels noisy	Everything looks bad at once	Check REF and BIAS first — a loose reference affects every channel
Packet loss / dropouts	Gaps or GUI warnings	Move dongle closer to the board (USB extension cable helps); remove nearby Bluetooth/WiFi sources; check battery
Large slow waves on front channels	Big rolling shapes at Fp1/ Fp2	Usually eye movement or sweat; check room temperature; remind participant to fixate
Sharp bursts on side channels	Spiky high-frequency bursts at temporal sites	Jaw clenching or chewing — ask participant to relax jaw
Markers missing	No events in the file	Check the LSL marker stream is visible in LabRecorder before starting; confirm the stimulus software is sending
BIOPAC signal lost	Flat or erratic ring signal	Refit ring; check pairing and battery

Add lab-specific fixes as you find them.

Appendix B: Montage map

Board	Pin	Channel #	10-20 site	Notes
Cyton	N1P	1	**[fill in]**	
Cyton	N2P	2	**[fill in]**	
Cyton	N3P	3	**[fill in]**	
Cyton	N4P	4	**[fill in]**	
Cyton	N5P	5	**[fill in]**	
Cyton	N6P	6	**[fill in]**	
Cyton	N7P	7	**[fill in]**	
Cyton	N8P	8	**[fill in]**	
Daisy	N1P	9	**[fill in]**	
Daisy	N2P	10	**[fill in]**	
Daisy	N3P	11	**[fill in]**	
Daisy	N4P	12	**[fill in]**	
Daisy	N5P	13	**[fill in]**	
Daisy	N6P	14	**[fill in]**	
Daisy	N7P	15	**[fill in]**	
Daisy	N8P	16	**[fill in]**	
Both	SRB (ganged)	—	REF: earlobe/mastoid	Via Y-splitter
Cyton	BIAS	—	GND: mastoid	

Appendix C: Adverse events

If a participant feels faint, dizzy, unwell, distressed, or asks to stop:

1. **Stop immediately.** Their wellbeing comes before the data.
2. Remove the cap and ring if they want it off. Help them sit comfortably; offer water.
3. If it's a medical emergency, call **911**, then campus security: **[fill in]**.
4. If they're emotionally distressed (e.g., by the trust-violation manipulation), talk with them calmly, explain the study as in the debrief, and offer support resources: **[fill in]**.
5. Pay compensation per the approved protocol — stopping early doesn't forfeit payment unless MREB-approved terms say otherwise.
6. Notify the supervisor the same day: **[fill in names]**.
7. Report to MREB as required by the approval: **[fill in timeline]**.
8. Write down what happened, when, and what you did, in the session log.

Appendix D: Session log template

```
Study code:            Participant ID:          Date:
Researcher(s):         Start time:              End time:
Condition order:       Cap size:                Nasion–inion (cm):

Eligibility confirmed: Y / N
Screening – caffeine:        sleep (hrs):        hair products:
            allergies:       medications/neuro:  handedness:

Impedances (kΩ) at start:
  Ch1   Ch2   Ch3   Ch4   Ch5   Ch6   Ch7   Ch8
  Ch9   Ch10  Ch11  Ch12  Ch13  Ch14  Ch15  Ch16
Impedances rechecked between blocks (note changes):

Sync events sent (start / end):   Y / N    Y / N
Packet loss noted:
Robot distance (m):
Questionnaires completed:
Data verified before participant left:   Y / N
Files saved (EEG / markers / BIOPAC / stim log / questionnaires):
Backed up to (1):                (2) MacDrive:
Compensation paid:
Debrief given (incl. deception reveal):   Y / N
Data withdrawal requested:   Y / N

Anything unusual (with times):

Protocol fixes to consider:
```

The one-line version

Question + measure → ethics → design (eligibility, exclusions, analysis plan) → script → system setup & sync → pilot on yourself → prep gear → prep room → consent, eligibility & screen → check scalp, cap, gel & impedance → sync, baseline → marked, monitored recording → verify before they leave → debrief (incl. deception) → name, back up, log, clean & disinfect.