Speculative Commentary and Interpretive Hypotheses
Longitudinal qEEG and ERP Dataset (3 sessions, May to July 2024)

This document is intentionally qualitative. It offers interpretive possibilities, not diagnoses, not treatment advice, and not causal claims. Hypotheses are listed as competing models rather than a single narrative.

Interpretive anchor: a topographic reweighting story

The most informative single detail in the dataset is the per-electrode P300 panel. It shows that the P300 delay metric improves largely because the earliest qualifying latency shifts to right C4, while P300 amplitude shifts leftward by Session 3 (C3 and P3 become the largest). This combination suggests reweighting of generators or selection of a different leading site, not a uniform speedup everywhere.

- Right C4: latency becomes earlier across sessions while amplitude stays lower than Session 1 by Sessions 2 and 3.
- Left C3 and P3: amplitude increases strongly by Session 3 with a smaller latency shift.
- The device-reported P300 delay is winner-based, so a single site can dominate the global story if it becomes earliest.

What this topographic signature could mean

- **Generator migration**: the dominant evoked generator shifts across hemispheres over time, with the leading edge moving to right C-P timing while left C-P recruitment strengthens.
- **Compensatory division of labor**: one subsystem optimizes early selection timing (right C-P), while another increases recruitment to support robustness (left C-P).
- **State plus metric sensitivity**: the observed pattern reflects changes in signal-to-noise and threshold crossing at specific electrodes, amplifying the impact of a winner-based delay definition.
- **Network constraints**: decreasing interhemispheric beta coherence by Session 3 could limit bilateral integration and push more unilateral control, while alpha coherence changes reflect coordination modes that depend on task and vigilance.

Stage opposition: early sensory timing vs evaluative timing

N100 latency drifts later while P300 delay drifts earlier. A single mechanism is not forced by that pattern. It supports a pipeline view where sensory registration, evaluative selection, and motor output can vary independently across sessions.

- A later N100 can be driven by state, filtering, or SNR shifts without implying structural slowing.
- A faster P300 delay metric can be driven by a leading-site shift without implying global cortical acceleration.

- A slower physical reaction time can be driven by response strategy and inhibition thresholds, not only by motor execution.

Task-network anatomy that deserves attention

The Flanker alpha coherence pattern is anatomically split: long-range frontal-to-posterior edges decrease while temporal-involving edges increase. This can be framed as functional gating that reduces long-range idling synchrony during task engagement, paired with increased temporal coordination.

Behavioral metrics: useful but fragile

Trail Making and reaction time provide context, but sub-minute tasks are sensitive to interruption and learning. The Session 3 TMT-B faster-than-TMT-A pattern is a validity constraint, so behavioral narratives should stay hypothesis-level unless replicated.

Data that would collapse uncertainty quickly

- Artifact and yield logs for P300 and N100 by electrode, plus latency distributions across all central-parietal sites.
- Standardized acquisition conditions with explicit notes on sleep, caffeine, medication timing, and distractions.
- Additional sessions to estimate within-person variability and confirm whether the lateralized P300 pattern persists.
- Item-level or examiner-noted TMT timing to adjudicate interruption versus genuine set-shifting change.
- Intervention timing relative to qEEG collection, if intervention context exists.