Team Number: 15

Team Members:

Riley England

Jackson Yanek

Manu Redd

Mya Hoersdig

Abdelrahman Zeidan

Project Name: Attune

1 Synopsis: Mobile EEG-based self-experiment application that analyzes short-term focus stability across location, music, and time of day to identify optimal focusing conditions.

2 Architecture:

Attune follows a layered architecture and analysis pipeline. At a high level, the system separates signal acquisition, processing and analysis, and user-facing interpretation.

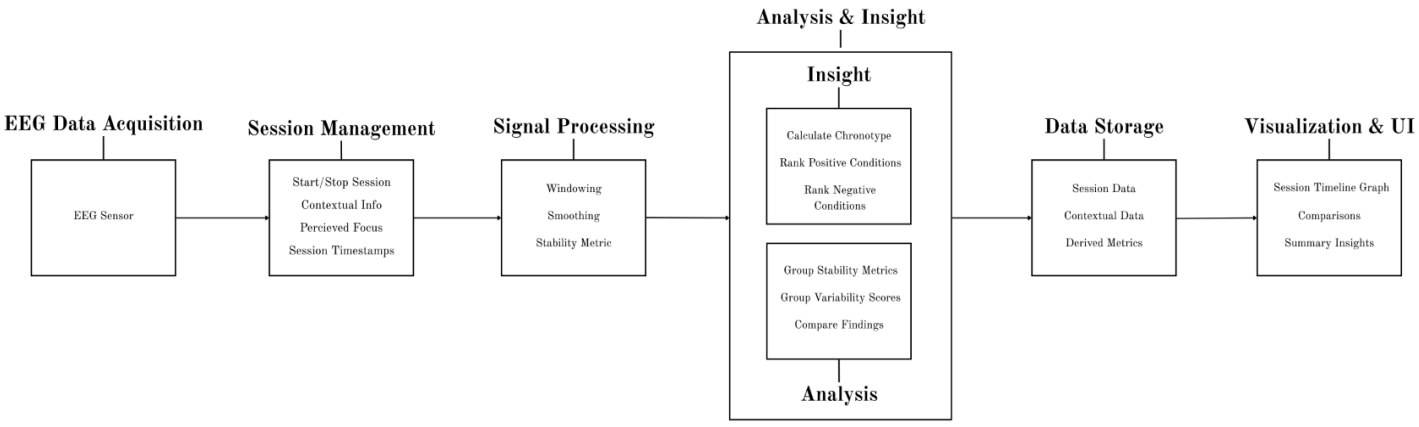

Figure 1 presents the overall system architecture. EEG data is captured via a consumer EEG headset and passed through a dedicated EEG interface layer. The mobile application orchestrates session control, contextual metadata collection, and data storage. A processing module converts EEG-derived engagement signals into focus stability metrics, which are then aggregated and visualized to produce user insights.

2.1 EEG Data Acquisition Layer

The EEG Data Acquisition Layer is responsible for establishing and maintaining communication with the EEG headset using the manufacturer's Android SDK. This subsystem avoids hardware-specific quirks and provides a consistent data stream to the rest of the application.

Isolating the EEG acquisition into a dedicated layer ensures that following modules receive processed data as opposed to raw metrics. This also supports a fallback so that we can demonstrate the functionality using pre-loaded data.

2.2 Session Management Layer

The Session Manager is responsible for the lifecycle of a focus session. It serves as the primary control logic of the application and mediates between the User Interface, EEG Interface, and Processing Module.

Responsibilities include:

- Starting and stopping focus sessions

- Capturing timestamps automatically (e.g. distractions, period of stable focus)
- Associating EEG data with session identifiers
- Collecting user-provided context (e.g. location, music, time of day, type of work)
- Recording perceived focus ratings after each session

This component ensures that EEG data and contextual metadata remain synchronized throughout the session.

2.3 Signal Processing Layer

The Signal Processing module converts EEG-derived engagement signals into a focus stability metric, which serves as the system's primary dependent variable.

Rather than attempting to classify focus directly, the system measures the temporal stability of an engagement proxy over time. EEG engagement values are segmented into short overlapping windows, and variability within each window is computed. Lower variability corresponds to more sustained attention.

To improve the robustness and reliability of the data, the input will be smoothed using rolling averages, and data with poor signal quality is down-weighted or excluded. Each session would produce both a stability-over-time curve and session-level aggregate stability score.

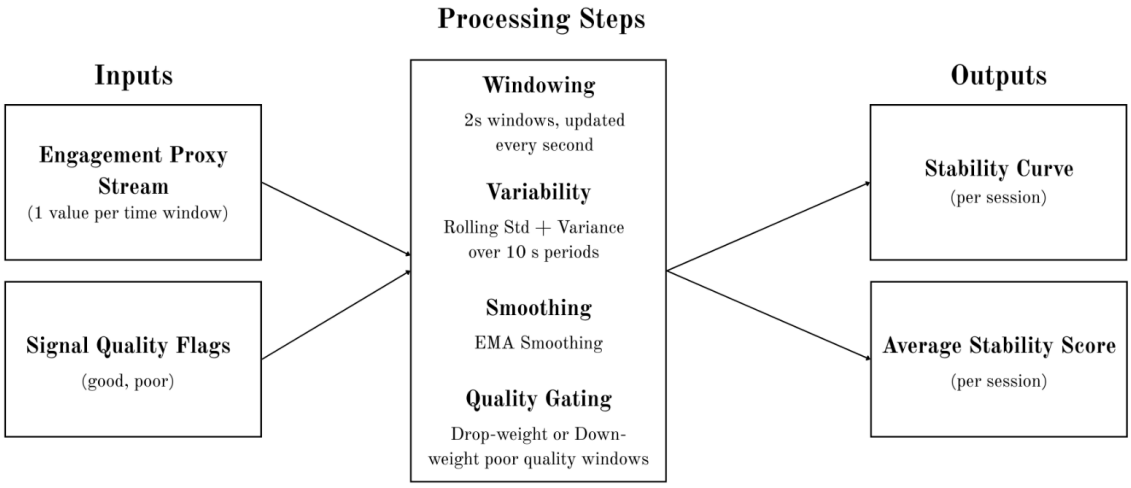

Figure 2 displays the focus stability computation pipeline, from raw data to filtered data.

2.4 Analysis & Insight Layer

The Analysis & Insight Layer aggregates stability metrics across multiple sessions grouped by contextual variables:

- Location
- Music
- Time of Day
- Type of Work (e.g. Creative, Deep, Light)

The module computes average stability scores and variability across groups, enabling relative comparisons. These comparisons form the basis for identifying optimal and suboptimal focusing conditions.

Chronotype analysis is implemented as an extension of the metrics collected. The system will provide an estimated chronotype, the confidence level in the prediction, and the user's overlap with said predicted chronotype.

2.5 Data Storage Layer

The Data Storage Layer will employ a local-first data storage architecture using a structured database schema.

Stored entities include:

- User Information (Account UID)
- Session Metadata
- Contextual Annotations
- Derived Focus Stability Metrics
- User Self-Reports

Raw EEG data is not stored. The user will, at any time, have the option to delete specific sessions, or perform a complete wipe.

2.6 Visualization and User Interface Layer

The Visualization and User Interface Layer presents the derived analytical information in an interpretable, clean, and non-diagnostic manner.

The UI includes:

- Session-specific graphs showing focus stability over time

- Comparative charts across locations, music conditions, time of day, and type of work bins
- Ranked summaries of optimal and least optimal focusing conditions for each independent variable
- Confidence indicators based on the number of contributing sessions

The interface described explicitly communicates findings of the sessions while acknowledging limitations and lack of diagnostic criteria.

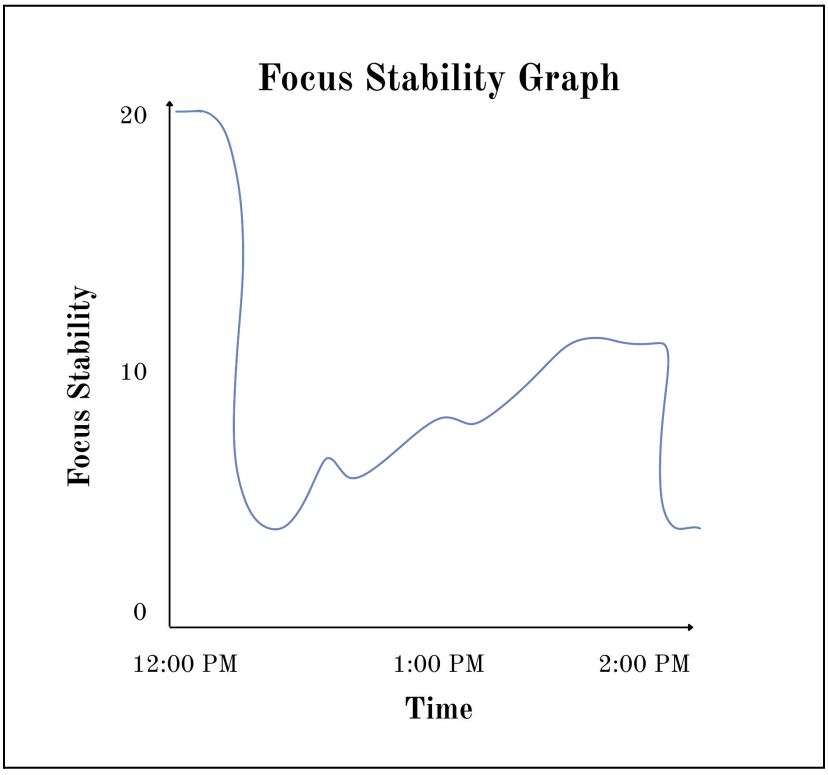

Figure 3 depicts an example focus stability graph provided to the user.