Response to the final thesis review by Prof. Dr. Kozlovszky Miklos

Dear Prof. Kozlovszky,

Thank you very much for your thorough and careful review of my revised dissertation as well as for your positive recommendation to proceed to the public defence. I truly appreciate your continued support throughout both the in-house and current review processes.

Regarding the reference issue you highlighted: I have cross-checked the clean full thesis (the version without highlighted changes), and the reference source that appeared as "not found" was not actually missing. In the highlighted version, the reference link was incorrectly attached/not updated, which caused the error. I apologise for this oversight. I would also like to clarify and assure that the printed clean thesis contains no reference error and the references are all correctly linked. Thank you again for pointing this out.

Below I respond to the three questions you raised.

Q1: Can we properly characterize the viewing session with global or window-based EEG measures (e.g. average power of a specific frequency band, average connectivity measures)?

Traditionally, global EEG measures such as average power or connectivity have been used to provide a summary of neural activity over relatively short post-stimulus intervals, where the neural response can be reasonably treated as a temporally constrained or relatively stable response. Averaging across such intervals can therefore provide a meaningful summary of the underlying neural activity. However, this approach becomes more limited during prolonged naturalistic viewing, where neural activity changes continuously over time [1] and a single average across the entire 8-second period may obscure meaningful temporal dynamics [2].

In the current thesis, sustained oscillatory activity during the painting viewing period was examined using time-frequency/ERSP analysis (Figure 22 in the dissertation). This showed sustained activity across multiple frequency bands during prolonged viewing, indicating that neural activity was not limited to the initial stimulus-locked response. At the component level, the temporal dynamics can differ greatly between components even within the same participant. Figure 1 illustrates the temporal variation in component power across the viewing period, while Figure 2 shows two components from the same participant with different temporal patterns: IC6 shows significant changes in oscillatory activity across the viewing period, whereas IC8 remains comparatively stable. This illustrates that global averaging activity across the entire viewing period may obscure temporal dynamics.

A window-based approach could therefore provide a more informative characterisation by retaining some of the temporal structure of the viewing period. For example, connectivity could be estimated at different time points or across successive windows rather than being reduced to a single value for the entire viewing period. The preliminary wavelet-based alpha band connectivity analysis shown in Figure 3 illustrates differences in connectivity patterns at different time points during the painting viewing period (N=29). However, during prolonged naturalistic viewing, participants make multiple saccades and fixations at different and unpredictable times. Therefore, connectivity estimated over longer intervals may combine neural activity associated with different fixation events and stages of viewing, making the resulting connectivity more difficult to interpret.

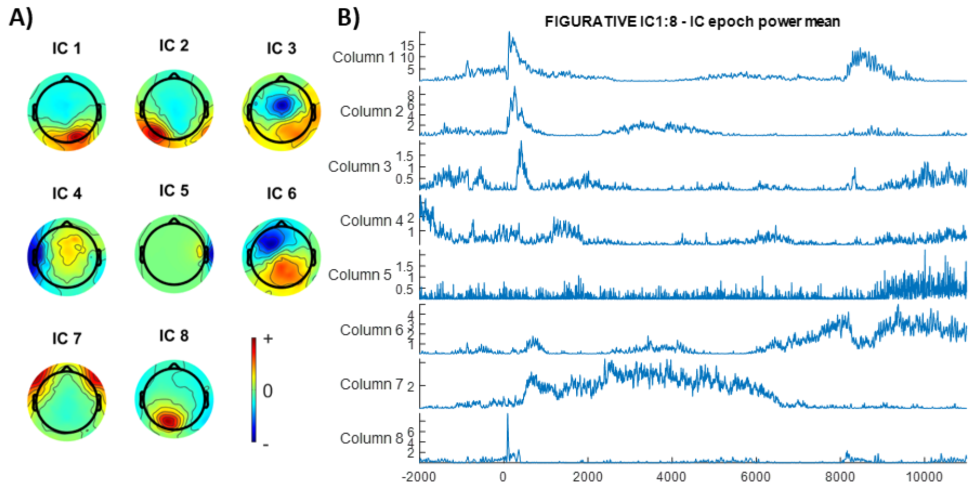

Figure 1. (A) Scalp topographies of the ICA components and (B) ICA component power during prolonged painting viewing after applying a 0.1 Hz high-pass filter. Column 1-8 indicates IC 1-8. The temporal variation in component activity across the viewing period illustrates that neural activity is not necessarily stationary throughout the session and may therefore be obscured by a single average measure.

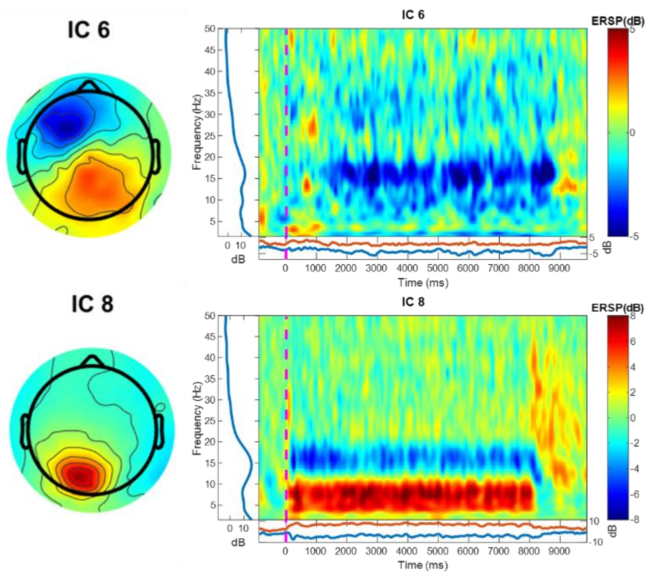

Figure 2. Time-frequency (ERSP) representations of two independent components from the same participant during the painting viewing period. The two components exhibit distinct temporal patterns of oscillatory activity, with IC6 showing greater temporal variation and IC8 showing comparatively stable activity throughout the viewing period.

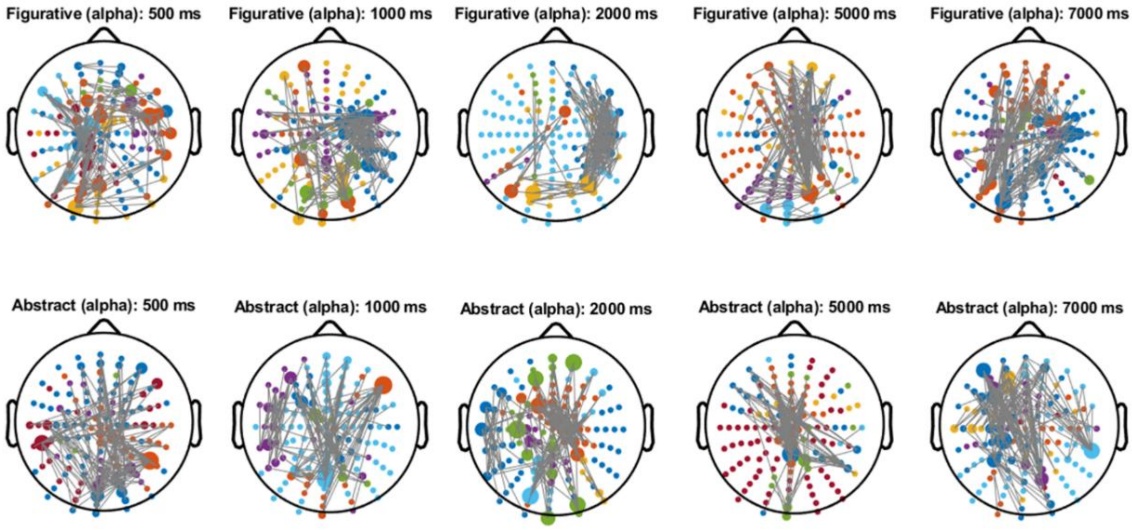

Figure 3. Group averaged time-resolved alpha band connectivity across the painting viewing period (N=29). Connectivity was estimated using wavelet-based analysis at selected time points during the 1-7 second viewing period.

Therefore, while global measures can provide a useful broad characterisation of the viewing session, window-based measures can better preserve temporal changes during prolonged viewing. Nevertheless, for naturalistic viewing, retaining the single-trial structure may provide a more informative approach. The ICA framework developed in this thesis provides a potential basis for separating the mixed EEG signal into neural components and examining their temporal activity on a single-trial basis. Future work could therefore combine time-resolved connectivity with component-level and single-trial analyses to investigate how neural activity and connectivity evolve throughout prolonged naturalistic viewing.

Q2: The dissertation showed the use of ICA for detecting occipital lambda responses. Could this method be used for identifying other cortical activation sources as well? If so, what would be the benefit?

Yes, ICA can potentially be used to identify other neural components associated with different cortical processes [3], [4]. The use of ICA in this dissertation is not specific to the lambda response. Since ICA separates the recorded EEG signals into statistically independent components based on their spatial and temporal characteristics, the same approach can potentially be used to identify other neural components that have distinct spatial or temporal features. In this sense, an ICA component can provide a spatially and temporally distinct representation of activity that can be extracted from the mixed EEG signal and examined separately. The main benefit is that ICA can help separate overlapping neural processes and artifacts that are mixed at the scalp level, allowing individual components to be characterised more specifically.

For example, the present ICA decomposition already produced multiple components with distinct scalp topographies and temporal activity patterns. The example shown in Figure 4 illustrates several occipital components with different spatial distributions and waveforms. These components could potentially represent different aspects of visual processing, although their specific anatomical or functional origins would require further validation. Similarly, components associated with motor responses or other task-related activity (Figure 1A) could potentially be identified and analysed separately. Separating such components may provide a clearer characterisation of the different neural processes contributing to the observed EEG activity and their temporal relationships during the task.

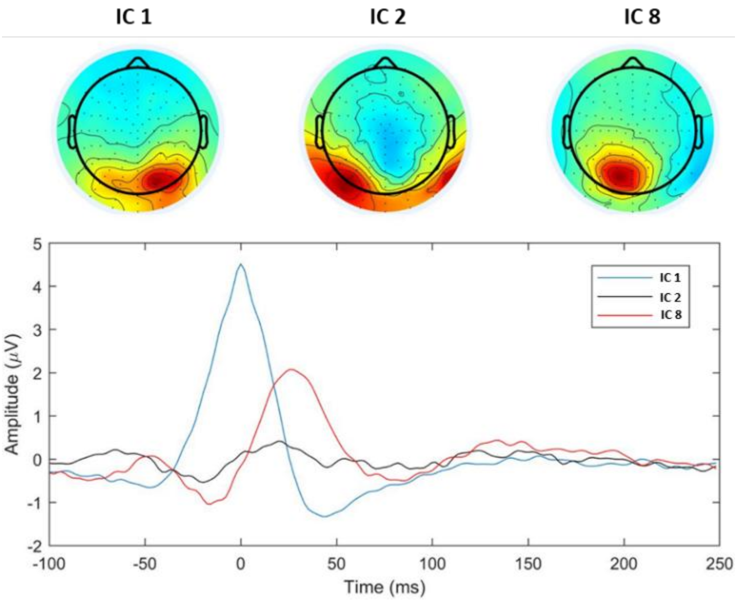

Figure 4. Scalp topographies and temporal waveforms of selected ICA components from a single subject. The components exhibit distinct spatial distributions and temporal characteristics, illustrating the separation of different components from the mixed EEG signal.

The lambda response demonstrated in this thesis therefore represents one example of a broader component-based approach. The same principle could potentially be extended to other event-related or oscillatory responses and other task-related neural components, provided that they exhibit sufficiently distinct spatial and/or temporal characteristics. I did not investigate these additional components in the present thesis, but this represents a potential future extension of the ICA-based framework.

Q3: The lambda responses were detected during viewing paintings. Is the method generalizable to investigate other cognitive tasks, e.g. reading, programming, gaming?

Yes. In principle, the method is not limited to painting perception, as the lambda response is associated with visual processing following fixation [5]. It could therefore potentially be applied to other visually guided tasks involving eye movements, such as reading, programming, gaming or driving experiments. The main requirement is that eye movements and fixation events can be accurately detected and synchronised with the EEG recordings, allowing the neural activity following each fixation to be extracted and analysed. This would make it possible to investigate fixation-by-fixation neural dynamics in more naturalistic tasks, rather than relying only on stimulus-locked responses. Depending on the task, the fixation-locked activity could also provide information about how neural processing changes with different attentional demands or levels of task engagement. In this sense, the ICA-based lambda detection method developed in this thesis could serve as a general framework for studying fixation-related neural activity across a wider range of visual and cognitive tasks.

I thank you once again for your careful reading of the dissertation and for the constructive questions above, which I believe strengthen the discussion of the work's scope and its natural next steps.

Veszprem, 09.09.2026. ……………………………………………

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References

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