Response to the final thesis review by Prof. Ferenc Bari

Dear Prof. Bari,

Thank you 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. Below I respond to the two points you raised.

Q1: There are two parallel pathways in the visual system (magno- and parvocellular); one conducts the signal faster, while the other does so more slowly. At the same time, the slower pathway is responsible for revealing fine details. What considerations led to the choice of an 8-second observation window followed by a 4-second decision window? What is the minimum observation interval at which a decision is already made—that is, is it possible to classify the 8-second recordings in a specific way based on when the decision was made? What would a moving average show over a 1—7-second interval, for example, in the alpha band? In other words, can we infer from the dynamic changes in connectivity (which are clearly illustrated in the figures) when the decision will occur?

Since Q1 contains several sub-questions, I answered each one individually as follows:

1. What considerations led to the choice of an 8-second observation window followed by a 4-second decision window?

The magnocellular and parvocellular pathways illustrate that the initial visual processing of an image occurs on a much shorter timescale than the 8-second observation period. Previous literature [1], [2], [3], [4] also suggests that an initial aesthetic impression or evaluation can emerge within the first few seconds of viewing. However, the 8-second duration in the present experiment was not intended to represent the time required for basic visual recognition or aesthetic decision formation. Rather, it was selected to extend beyond this initial period and provide a sufficiently long free-viewing interval for participants to explore and contemplate each painting naturally. This allowed perceptual processing to develop through multiple fixations and saccades and potentially progress from early perceptual analysis toward interpretation and evaluation, consistent with the multi-stage aesthetic processing framework adopted in the dissertation [1], [5].

The extended viewing period also allowed us to consider whether neural dynamics during the later part of viewing might differ from the early processing typically reported in the literature [1], [6]. In Chapter 3 of the dissertation, connectivity was examined as early as 100 ms after stimulus onset, reflecting the rapid onset of visual processing. However, these timepoints were selected based on the ERP peaks observed in the data, rather than being directly determined by the timing of magnocellular or parvocellular processing. Thus, the 8-second period provided an opportunity to extend the observation beyond these early stimulus-locked responses and to accommodate the more prolonged and recurrent processes associated with naturalistic viewing.

The 8-second duration also represented a practical compromise between allowing sufficient time for natural exploration and keeping experiment duration within limits as well as to maintain participant engagement and data quality across the 80 trials. The subsequent 4-

second break period was separated from the viewing period to allow participants to report their Like/Dislike judgement without introducing button-press-related motor activity into the main viewing epoch. It also provided a brief interval between the prolonged viewing period and the response, reducing the need for participants to prepare the motor response while viewing the painting and offering a brief moment for the eyes to rest before the next trial.

2. What is the minimum observation interval at which a decision is already made—that is, is it possible to classify the 8-second recordings in a specific way based on when the decision was made?

The current experiment does not allow me to determine the exact moment at which the participant internally formed the Like/Dislike judgement. The behavioural response was collected after the 8-second viewing period, so the recorded button press provides a measure of when the judgement was reported, not necessarily when the underlying decision was formed. Moreover, decision-making during naturalistic viewing is unlikely to be a single, linear process. Throughout the 8-second observation period, participants continuously make implicit decisions about where to look next, resulting in successive saccades and fixations. They may also revisit previously viewed regions of the painting and further update or refine their interpretation and evaluation. Thus, the Like/Dislike judgement may develop progressively or accumulating through repeated cycles of visual exploration, rather than being formed at one clearly identifiable moment.

In a follow-up self-paced eye-tracking experiment (not covered in this dissertation), participants viewed the same paintings and were asked to respond when they had made their decision. This provides a more direct behavioural estimate of the subjectively perceived moment of decision, although this measure should still be interpreted as a subjective marker rather than a precise reflection of the underlying neural decision process. However, the experiment is still in progress, so no further conclusions can be provided at this stage.

3. What would a moving average show over a 1—7-second interval, for example, in the alpha band?

A preliminary wavelet-based connectivity analysis was used to examine alpha-band connectivity at different time points during the 1-7 second viewing period, as illustrated in Figure 1. The connectivity patterns vary across the viewing period, suggesting that connectivity is not constant during prolonged viewing. However, these differences cannot yet be interpreted as decision-related effects without further statistical analysis. Since multiple saccades, fixations and other neural processes occur throughout the viewing period, a more systematic moving-window analysis would be required to determine whether these changes are related to the Like/Dislike judgement. This analysis will be pursued as future work.

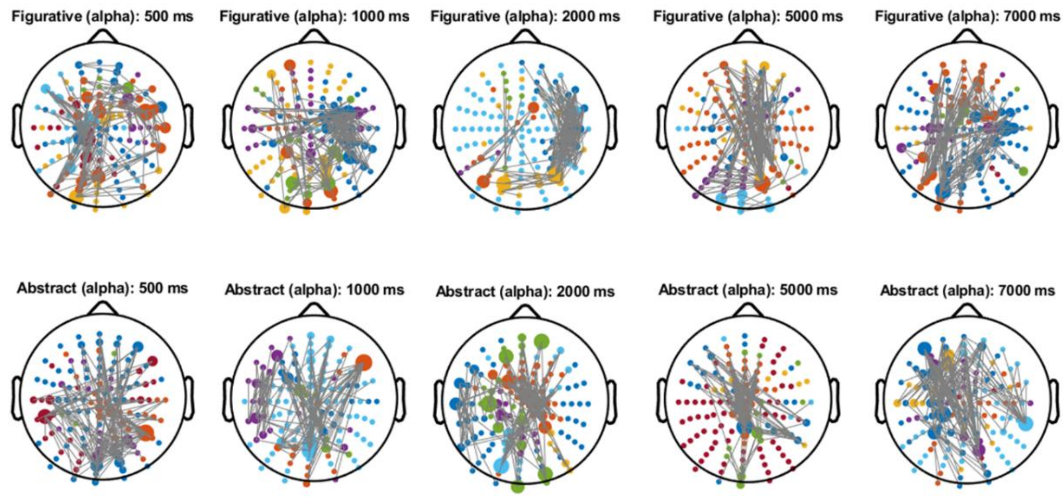

Figure 1. Group averaged time-resolved alpha band connectivity across the painting viewing period (N=29). Connectivity was estimated using wavelet-based analysis at selected time points during the 1-7 second viewing period.

4. In other words, can we infer from the dynamic changes in connectivity (which are clearly illustrated in the figures) when the decision will occur?

This is an interesting question and represents an important direction for future work. The dynamic changes in connectivity shown in Figure 1 indicate that connectivity varies across the viewing period. However, these changes cannot by themselves establish the exact moment at which the Like/Dislike judgement is formed. Early perceptual processing and perceptual decision-making may occur relatively early and involve predominantly visual, particularly occipital activity. In contrast, the aesthetic Like/Dislike judgement is a more complex process that may involve interactions between multiple brain regions. Therefore, it is difficult to distinguish connectivity related specifically to the aesthetic judgement from connectivity associated with ongoing visual processing during naturalistic viewing.

A more controlled paradigm, such as a Go/No-go experiment adapted to aesthetic judgement, could help address this issue by separating the viewing/perceptual phase from a more clearly defined decision phase. Such a design may make it easier to identify neural components specifically associated with the Like/Dislike decision. However, identifying such decision-related components remains challenging and would require appropriate experimental and statistical validation.

In line with the approach proposed in Chapter 5, the ICA-based framework could then be used to separate the mixed EEG signal into neural components and examine their activity on a single-trial basis. If a component could be reliably identified as being associated with the aesthetic judgement, its temporal activity could then be examined across individual trials to investigate when decision-related neural activity emerges. This would provide a potential direction for investigating the temporal dynamics of aesthetic decision-making, rather than assuming that the observed connectivity changes directly indicate the moment of decision formation.

Q2: In my previous comment, I asked whether the classic EEG frequency banding is suitable for analysing this type of problem. I received a somewhat ambiguous answer. Now I'm asking whether it's possible to refine the frequency band that is clearly suitable for characterizing connectivity.

I appreciate the clarification of this question. My previous response focused on the relevance of all five canonical frequency bands but I agree that this did not directly address whether the frequency range itself could be refined. In the present dissertation, connectivity was examined using conventional delta (1-4 Hz), theta (4.5-8 Hz), alpha (8.5-13 Hz), beta (13.5-30 Hz) and gamma (30.5-100 Hz) ranges. These five bands were selected based on conventional EEG practice and previous literature [7], [8], [9], [10], [11], providing an established basis for examining frequency-specific connectivity across the EEG spectrum.

However, the results do not indicate that aesthetic perception is restricted to one frequency band. Significant connectivity differences between abstract and figurative paintings were observed across all five bands and at all analysed post-stimulus time points. The spatial organisation nevertheless differed between bands: alpha showed strong posterior, (particularly occipital-parietal) connectivity; beta showed a more distributed pattern involving parietal and central regions; and gamma showed more focal occipital connectivity, while delta and theta showed relatively widespread patterns. Therefore, I would regard beta as an interesting candidate for further investigation rather than conclude that it is the clearly suitable frequency band. In the present results, beta connectivity showed distributed parietal and central involvement, which is particularly interesting in relation to the cognitive and evaluative demands of the task [10]. At the same time, the current analysis was not designed to statistically establish one canonical band as superior to the others.

A better refinement would therefore be to move beyond the fixed canonical boundaries and examine connectivity with finer frequency resolution. Rather than assuming that the predefined bands represent the most informative ranges, a data-driven approach could identify narrower frequency ranges in which the connectivity differences are most strongly and reliably expressed. Time-frequency approaches, such as wavelet analysis, could further allow the frequency-specific amplitude and phase characteristics to be examined dynamically over time. A data-driven decomposition such as empirical mode decomposition (EMD) [12], [13] could also be considered as an alternative for identifying oscillatory components without relying entirely on predefined frequency boundaries. Such approaches could provide a more detailed characterisation of how frequency-specific connectivity evolves over time, including beyond the 500 ms period examined in the present analysis. I did not implement this refinement in the present thesis, but I consider it an appropriate methodological extension of the current findings.

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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