

EXTERNAL REVIEWER'S EVALUATION REPORT

Candidate: Sena Nur BILGIN

Dissertation Title: *WHEN THE BRAIN TIMES ITSELF: Neural and Behavioral Mechanisms Underlying Temporal Error Monitoring Perspectives*

Supervisors: Prof. Mateusz Gola and Dr. hab. Tadeusz Kononowicz

Institution: Institute of Psychology, Polish Academy of Sciences

1. Overview and General Assessment

The doctoral dissertation submitted by Sena N. Bilgin addresses the mechanisms underlying temporal error monitoring (TEM), the ability to evaluate the accuracy of self-generated time intervals. This is a well-defined and theoretically productive research topic, situated at the intersection of interval timing and metacognition. The work is presented as a cumulative thesis comprising three published (two published papers and one preprint), with an introductory synthesis and a general discussion.

This thesis is a strong, coherent body of work that makes empirical and theoretical contributions to the field. The research is rigorous, theoretically motivated, and structured so that each paper builds on and extends the findings of the previous one. The candidate demonstrates knowledge of the relevant literature, appropriate use of statistical and computational methods, and the ability to situate experimental findings within broader theoretical frameworks. I recommend the dissertation for acceptance.

2. Summary of the Research Program

The central question of the dissertation is whether metacognitive evaluation of temporal performance constitutes a distinct higher-order process, or is based on the same neural and computational variables that govern timing performance itself.

Paper 1 (published in *iScience*, 2026) uses a cross-species comparative framework (comparing rats and humans) on the same TEM paradigm. Both species performed above chance, with rats demonstrating higher accuracy. The discrepancy was reduced when performance was equated for the representation of task-relevant threshold variables. **Paper 2** (published in *Consciousness and Cognition*, 2025) investigates the nature of the signal monitored during TEM. Using a motor manipulation, the paper tests a Clock Hypothesis (that participants monitor an internal temporal representation) against a Motor Hypothesis (that monitoring is driven by motor signal variability). Results supported the Clock Hypothesis, finding that conditions with a lower motor signal produced better TEM performance. **Paper 3** (submitted as a bioRxiv preprint, 2026) looked at single-trial EEG during a motor timing task to decode time production categories and metacognitive inference.

3. Strengths of the Dissertation

The three papers form a strong cumulative argument. The general introduction and discussion successfully present and integrate the findings, and the dissertation reads as an integrated program rather than a collection of independent experiments. The thesis combines behavioral experiments with humans and rats along with advanced statistical models to investigate TEM in both behavioral and EEG data.

The dissertation has a good theoretical framework and situates its findings within existing models in the literature, both in the timing literature and in metacognition more generally. The framing is clear, and the conclusions are proportionate, without overclaiming their findings.

The CRediT authorship statements and appended contribution forms confirm that the candidate led the conceptualization, experimental execution, data acquisition from human participants, statistical analyses, and manuscript drafting across all three papers.

4. Points for Discussion and Minor Concerns

Studies 1 and 2 have already been published in relevant journals and peer-reviewed. The only minor points I would like to suggest concern Experiment 3. Although the presented EEG analysis is sophisticated and justified by the objectives, it is important that the candidate test her analysis with more common methods, such as simple linear decoders (e.g., LDA, SVM, or others). This will give the reader a better understanding of the possible advantages or pitfalls of both methods.

5. Recommendation

The dissertation by Sena N. Bilgin represents a substantial and original contribution to the science of temporal metacognition. The research program is coherently designed, competently executed, and clearly written. The candidate demonstrates independent scientific thinking, a broad methodological toolkit, and the ability to situate her empirical findings within the theoretical landscape. Two of the three constituent papers have been published in peer-reviewed journals, and the third has been publicly disseminated as a preprint.

The minor points raised in Section 4 are intended to enrich the thesis and do not, in my assessment, constitute deficiencies that require correction before acceptance.

I recommend that the dissertation be accepted. The doctoral dissertation meets the conditions specified in art. 187 of the Act of 20 July 2018 - Law on Higher Education and Science (Journal of Laws of 2021, item 478, 619, 1630).



André M. Cravo, PhD

Associate Professor

Universidade Federal do ABC (UFABC)-Brazil