Response to Reviewer 1

Dear Reviewer,

Thank you for your thoughtful and constructive feedback. We are grateful for your time and expertise in reviewing our manuscript. We have carefully considered your comments, and we believe our revisions have significantly strengthened the paper.

You raised an important point regarding the need to explicitly address the limitations of the current study and provide a clear roadmap for future research. We agree that this is crucial for a commentary of this nature. In the revised manuscript, we have now dedicated an entire section titled **"Navigating the Challenges: Limitations and Future Directions"**.

Specifically, we have:

- **Expanded on the limitations of the cross-sectional design:** We now explicitly state that while the study identifies differences between groups, it cannot establish predictive power. We have also emphasized the need for large-scale, multi-year **longitudinal studies** to identify subtle kinematic changes that precede a formal MCI diagnosis and to predict progression to dementia.
- **Addressed the issue of sample size and diversity:** We have included a section that highlights the need for larger and more diverse cohorts spanning different geographical regions, ethnicities, and educational backgrounds to ensure the developed models are robust and generalizable to a broader population.
- **Incorporated the value of dual-task paradigms:** We agree that this is a critical point for enhancing sensitivity. We have added a section that

explains how cognitive-motor interference in dual-task settings can amplify subtle deficits and how integrating these paradigms could yield more sensitive and specific biomarkers.

- **Discussed the future role of wearable technology:** We have included a new section on moving "Beyond the Lab" and leveraging widely available wearable sensors for passive, continuous monitoring in real-world settings to provide more ecologically valid data.

We believe these additions provide a more balanced and forward-looking perspective, acknowledging the study's strengths while also transparently outlining the path for future validation and implementation.

We appreciate your guidance in making our commentary more robust and impactful.

Sincerely,

Takahiko Nagamine

Response to Reviewer 2

Dear Reviewer,

Thank you for your detailed and insightful comments. We appreciate your time and effort in providing such a thorough review of our manuscript. Your feedback has been instrumental in improving the clarity and depth of our paper, particularly concerning the role of machine learning.

You correctly identified that a more in-depth explanation of how machine learning was applied would be beneficial to the reader. We agree that simply stating "machine learning was used" is not sufficient to convey the full

innovation of the study.

In the revised manuscript, we have significantly expanded the section titled **"The Power of Multimodal Integration and Machine Learning"** to provide a more comprehensive explanation. Specifically, we have now:

- **Provided a clear, lay-friendly definition of Machine Learning:** We have explained that ML models act as "sophisticated pattern recognition engines" and their purpose is to learn patterns from data to make predictions or classifications.
- **Detailed the specific roles of ML in the study:** We have created a bulleted list to clarify exactly what ML algorithms did in this context. This includes:
    - Identifying discriminative features from a large number of kinematic parameters.
    - Uncovering complex, non-linear relationships that traditional statistical methods might miss.
    - Building predictive models to classify new individuals.
    - Handling high-dimensional data efficiently.
- **Explained the importance of the evaluation method:** We have added an explanation of **ten-fold cross-validation**, describing it as a technique that ensures the model's performance metrics (like the 74.44% accuracy) are robust and representative of its generalizability, not just a result of a specific data split.
- **Included the concept of "interpretability":** In the future directions section, we have added a point about the need for more **interpretable AI**

models. This directly addresses the "black box" concern, acknowledging that understanding why a model makes a particular decision is crucial for clinical adoption.

We believe these changes make the manuscript more accessible to a broader audience and better highlight the true scientific contribution of the study under review. Your feedback was crucial in helping us articulate this key aspect of the research more effectively.

Thank you again for your valuable input.

Sincerely,

Takahiko Nagamine