# Reliability of robotic TMS with 3D head models constructed by a depth camera

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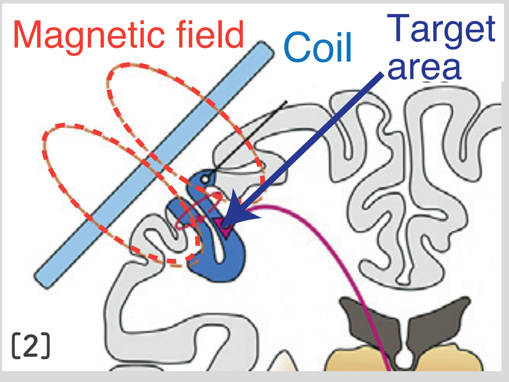
## Robotic TMS

Our robotic transcranial magnetic stimulation (TMS) system makes TMS experiments easier and more reliable.

[Functions]
Automatic adjustments of the position and orientation of the coil.
Fully automatic TMS evaluation, such as;
- Motor threshold & hotspot estimation
- IO curve, paired-pulse protocols
- Sulcus-aligned motor mapping[1]

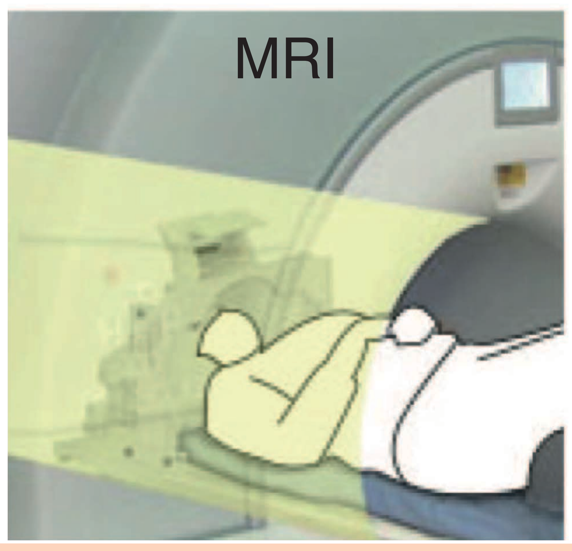
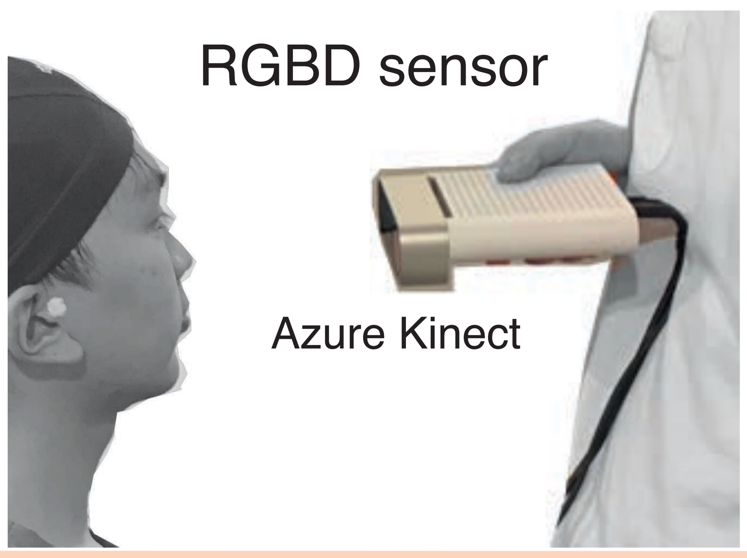
Current issue:
Robotic TMS requires an individual 3D head model scanned by MRI to place the coil tangential to the scalp, though MRI is not available in all research environments.




## Purpose

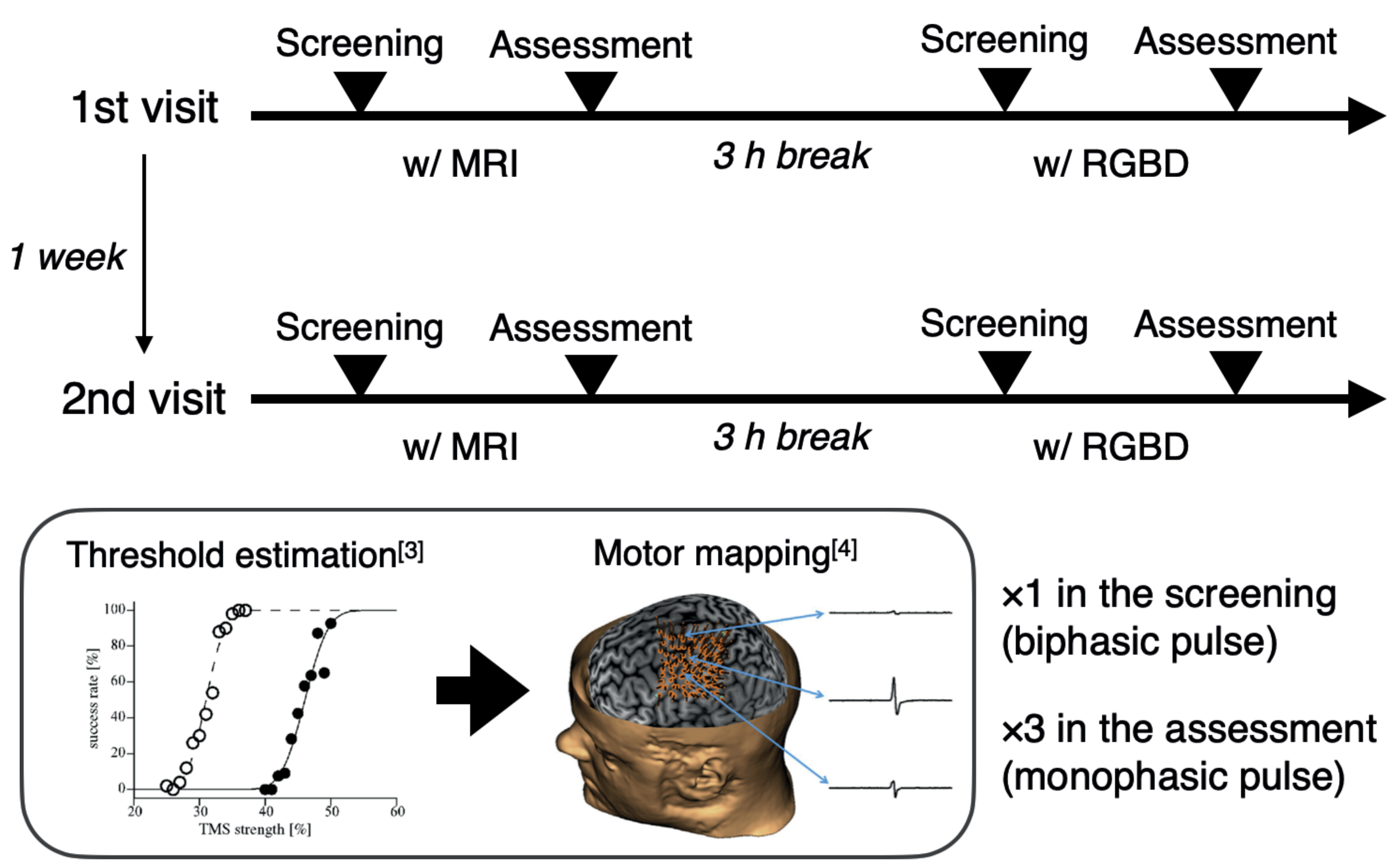
Comparing the reliability of robotic TMS with a 3D head model constructed using an RGBD sensor (Azure Kinect) and a head model made from MRI images.

### Head model reconstruction methods

| Typical approach | Our novel approach |
| --- | --- |
|  |  |
| Resolution: 0.85 mm isotropic<br>Advantage: established as a method<br>Limitations: installation & running costs | Resolution: 1.4 mm isotropic<br>Advantages: lower price & space saving<br>-> the reliability needs to be validated. |




## Study design




- Prior to the first visit, T1 and T2-weighted MRIs were acquired. MRI-based head models were created using the "headreco" function in simNIBS ver3.2.6[5].
- A head scan with the RGBD sensor is performed prior to the first screening.

## Result: Model accuracy

Video protocol

MRI-based models likely reflect the actual head shape more accurately than RGBD sensor-based models.

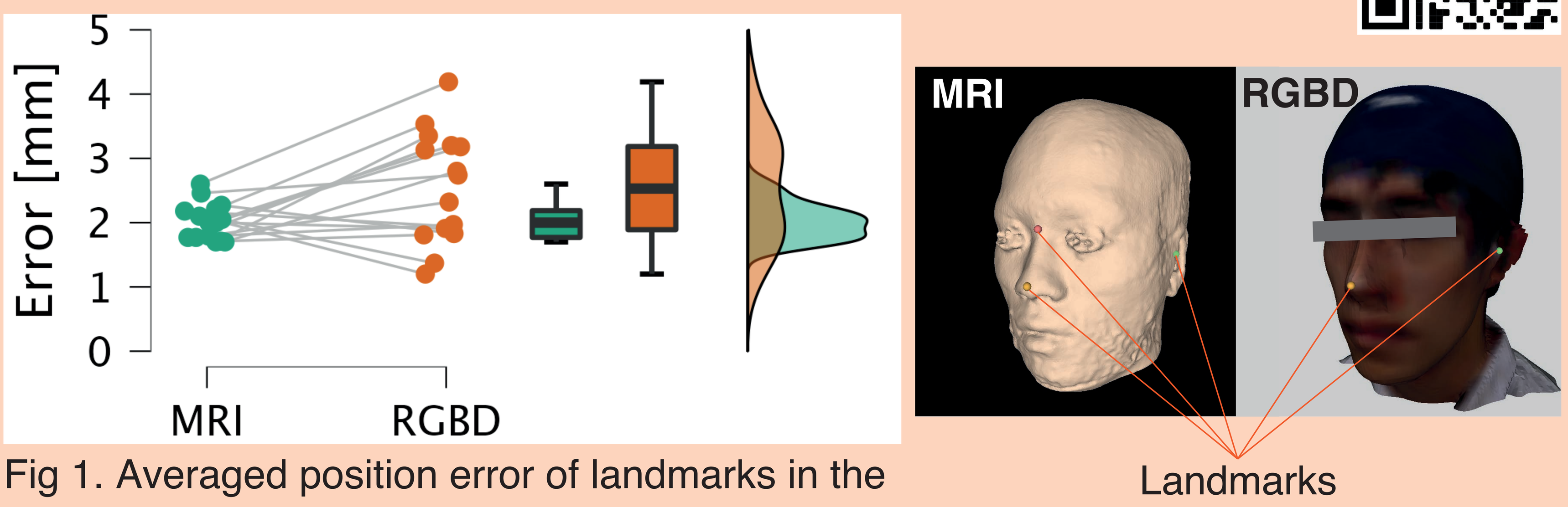
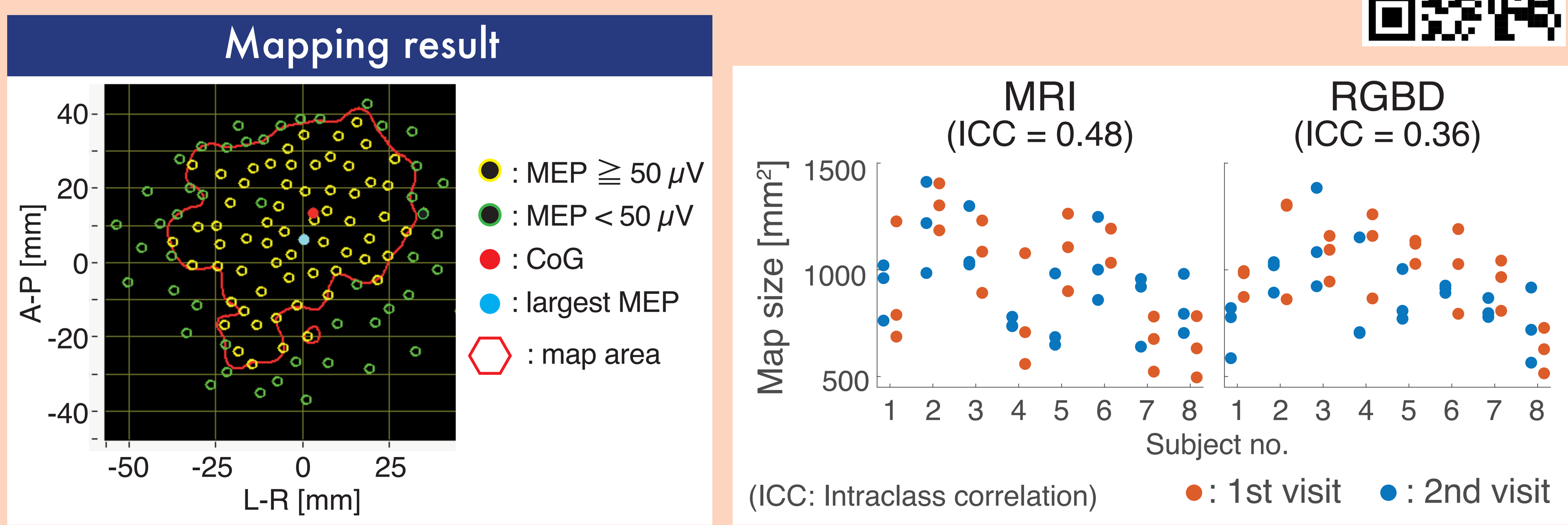



Fig 1. Averaged position error of landmarks in the model from the points scanned on the subject after co-registration of participants and head models.

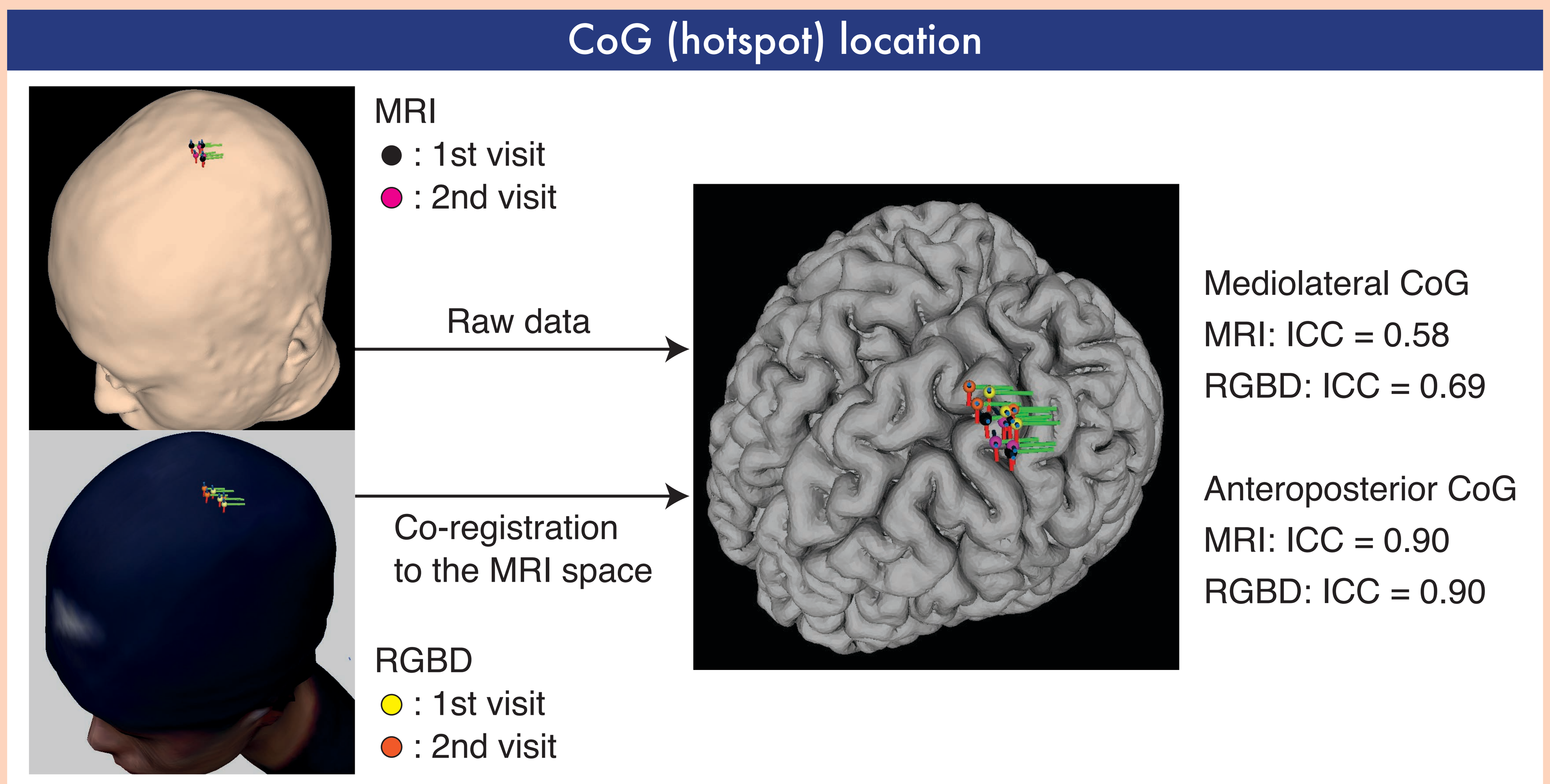
## Result: Motor map reliability

Video protocol

The size of estimated motor maps was not different between the head models and showed equivalently poor reliability[6].



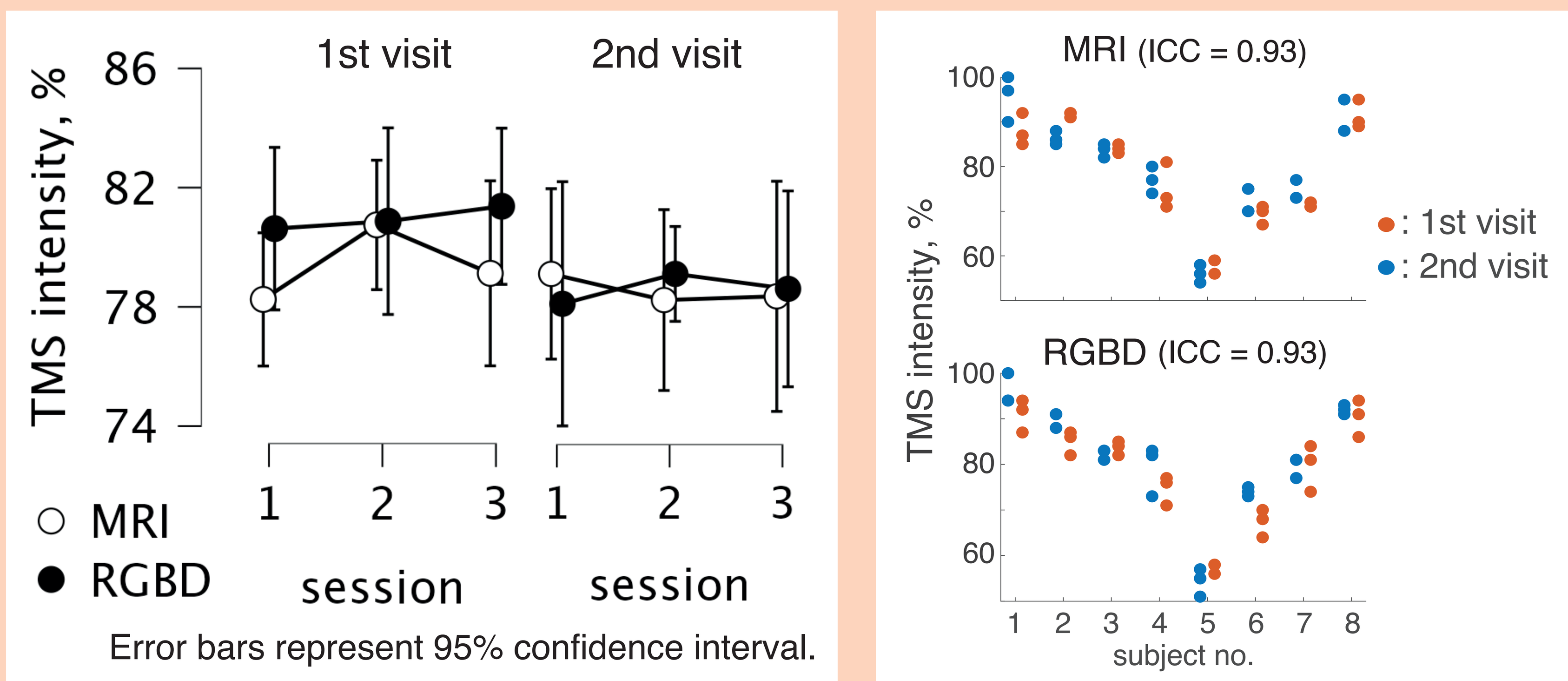

The location of the center of gravity (CoG) of estimated motor maps, called hotspot, showed moderate to good reliability for the both models.




## Result: Motor threshold reliability

Video protocol

Motor thresholds over the hotspot were not different between the head models and showed equivalently excellent reliability.




## Conclusions

The results demonstrated that hotspot and motor threshold are equivalently evaluated with both models, although MRI-based models likely reflect the actual head shape more accurately than RGBD sensor-based models. RGBD sensor-based head model can be utilized for the robotic TMS, particularly when MRI images are unavailable.

References
[1] Raffin et al., Neuroimage 2015.
[2] Weise et al., Neuroimage 2019.
[3] Awiszus, Suppl Clin Neurophysiol 2003.
[4] Ruit et al., Brain Stimul 2015.
[5] Thielscher et al., IEEE EBMS 2015.
[6] Koo & Li, J Chiropr Med 2016.

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