Klinikum rechts der Isar
Technical University of Munich

Non-invasive segmentation of individual watershed areas allows detection of hemodynamic impairments in internal carotid artery stenosis

Gabriel Hoffmann[1,2], Christine Preibisch[1-3], Franziska Richter[1], Matthias JP van Osch[4,5], Lena Václavů[4], Jan Kufer[1], Jannis Bodden[1], Michael Kallmayer[6], Jens Göttler[1], Claus Zimmer[1,2], Stephan Kaczmarz[1,2,7], Lena Schmitzer[1,2]

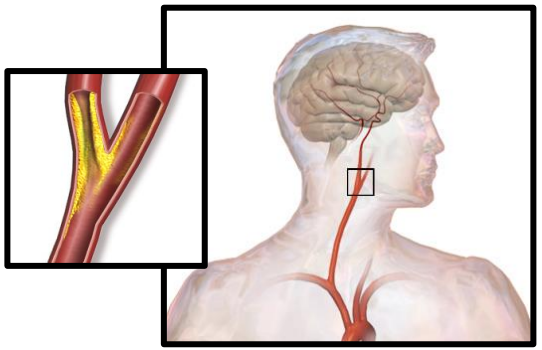
Session: Flow, Fluid Exchange & Microvasculature in the Human Brain

*gabriel.hoffmann@tum.de

1 Technical University of Munich, School of Medicine and Health, Department of Diagnostic and Interventional Neuroradiology, Munich, Germany
2 Technical University of Munich, School of Medicine and Health, TUM-Neuroimaging Center, Munich, Germany
3 Technical University of Munich, School of Medicine and Health, Clinic of Neurology, Munich, Germany
4 C.J. Gorter MRI Center, Department of Radiology, Leiden University Medical Center, Leiden, The Netherlands
5 Leiden Institute of Brain and Cognition, Leiden University, Leiden, The Netherlands
6 Technical University of Munich, School of Medicine and Health, Department of Vascular and Endovascular Surgery, Munich, Germany
7 Philips GmbH Market DACH, Hamburg, Germany

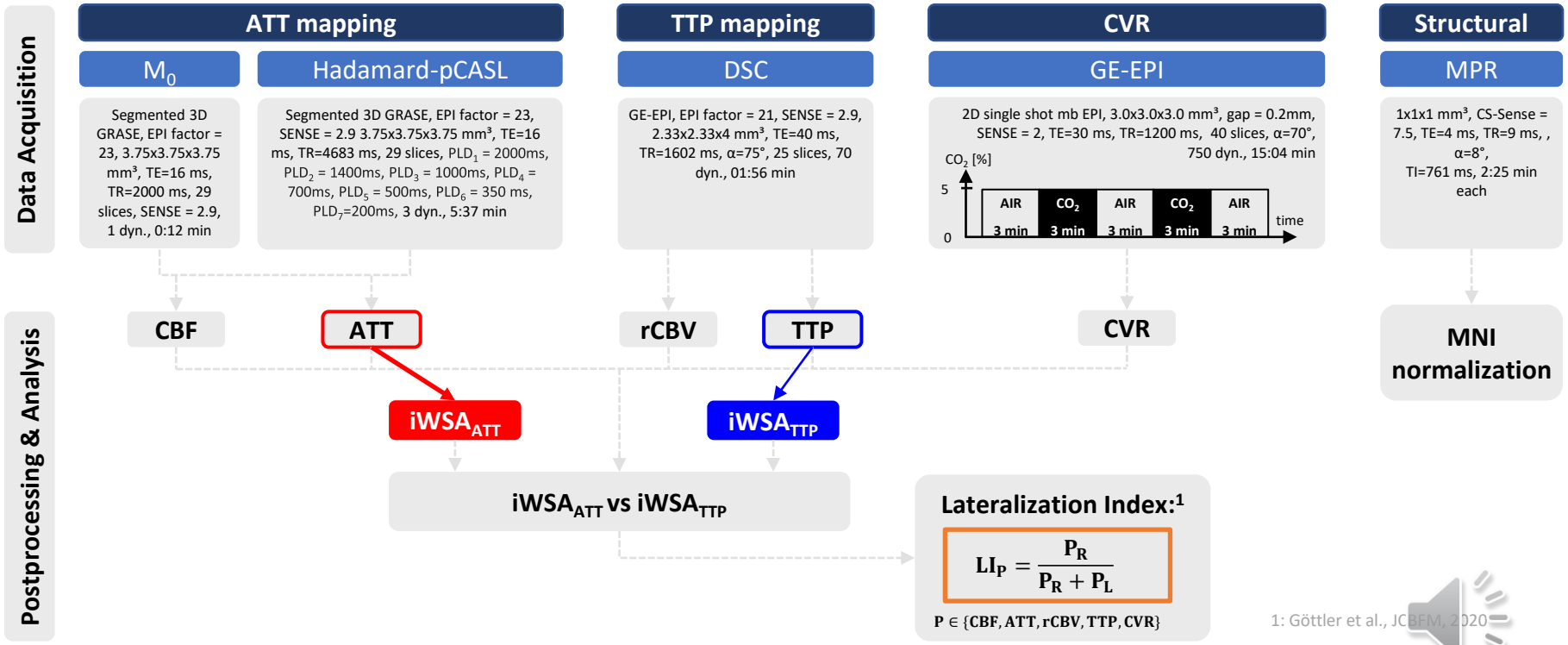
Internal Carotid Artery Stenosis (ICAS) and individual Watershed Areas (iWSA)

Background	• ICAS major health risk in developed countries[1,2] • Watershed areas (WSA) especially vulnerable[3,4] • Individual (i)WSA from DSC-based time-to-peak (TTP) maps[5,6]
Purpose	• Evaluate iWSA masks from non-invasive Arterial Transit Time (ATT) based on Hadamard pCASL
Hypothesis	• ATT-based iWSAs agree spatially with TTP-based iWSAs • Hemodynamic alterations within ICAS patients' iWSAs



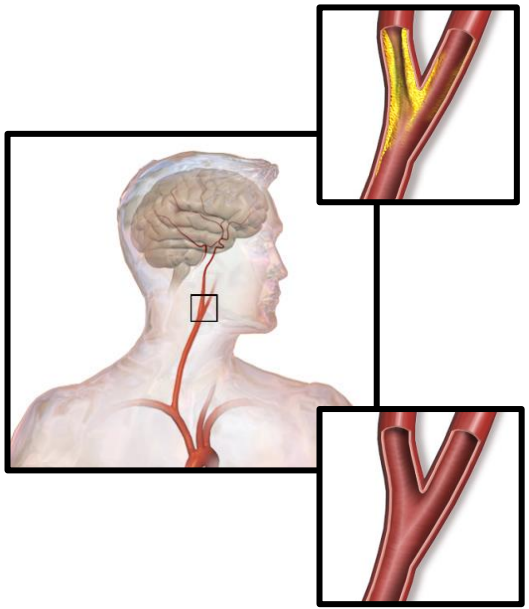
1: Donahue, JCBFM, 2018 2: Petty, Stroke, 1999 3: Momjian-Mayor, Stroke, 2005 4: Kaczmarz, JCBFM, 2021 5: Kaczmarz, Neuroradiology, 2018 6: Schmitzer, JMRI, 2021
Image: Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436.

MRI protocol and analysis for comparing iWSA from ATT and TTP



1: Göttler et al., JCBFM, 2020

Study population contains patients and age-matched HCs



ICAS

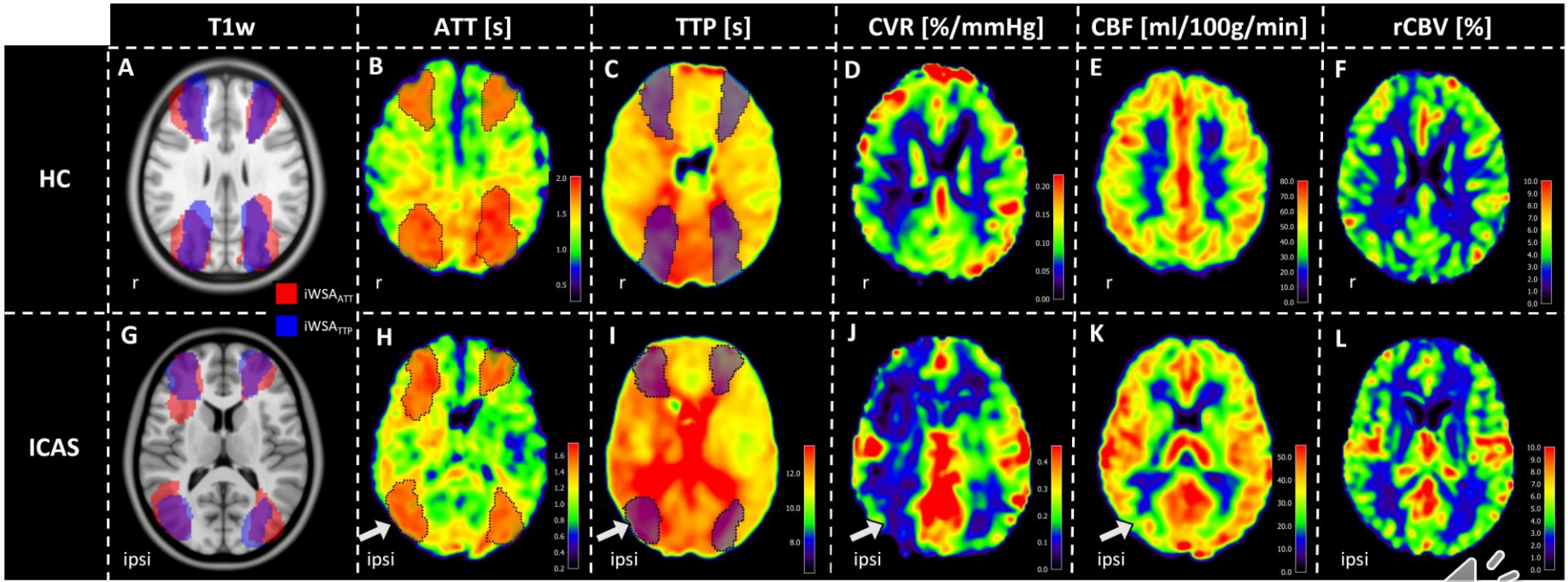
- 6 patients (age 71.7±8.8 years)
- 2 female / 4 male
- Unilateral
- NASCET >60%

Healthy controls (HC)

- 20 age-matched HCs (age 69.2±5.8 y)
- 12 female/ 8 male

Image: Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436.

Exemplary data of a Healthy Control (HC) and an ICAS patient

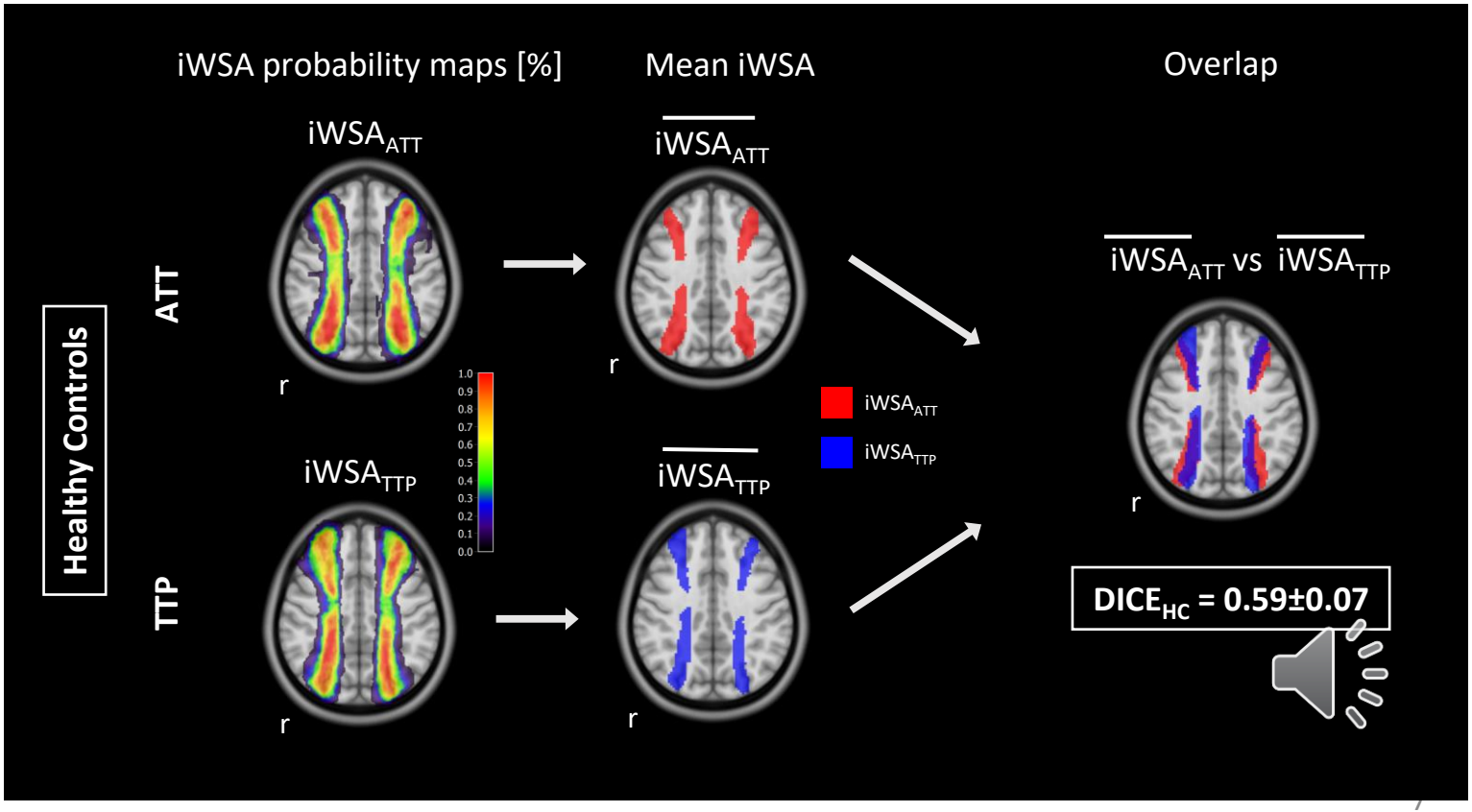


→ iWSA$_{ATT}$ concord with iWSA$_{TTP}$ (B,H vs C,I)

→ ICAS induces lateralization (H-L)

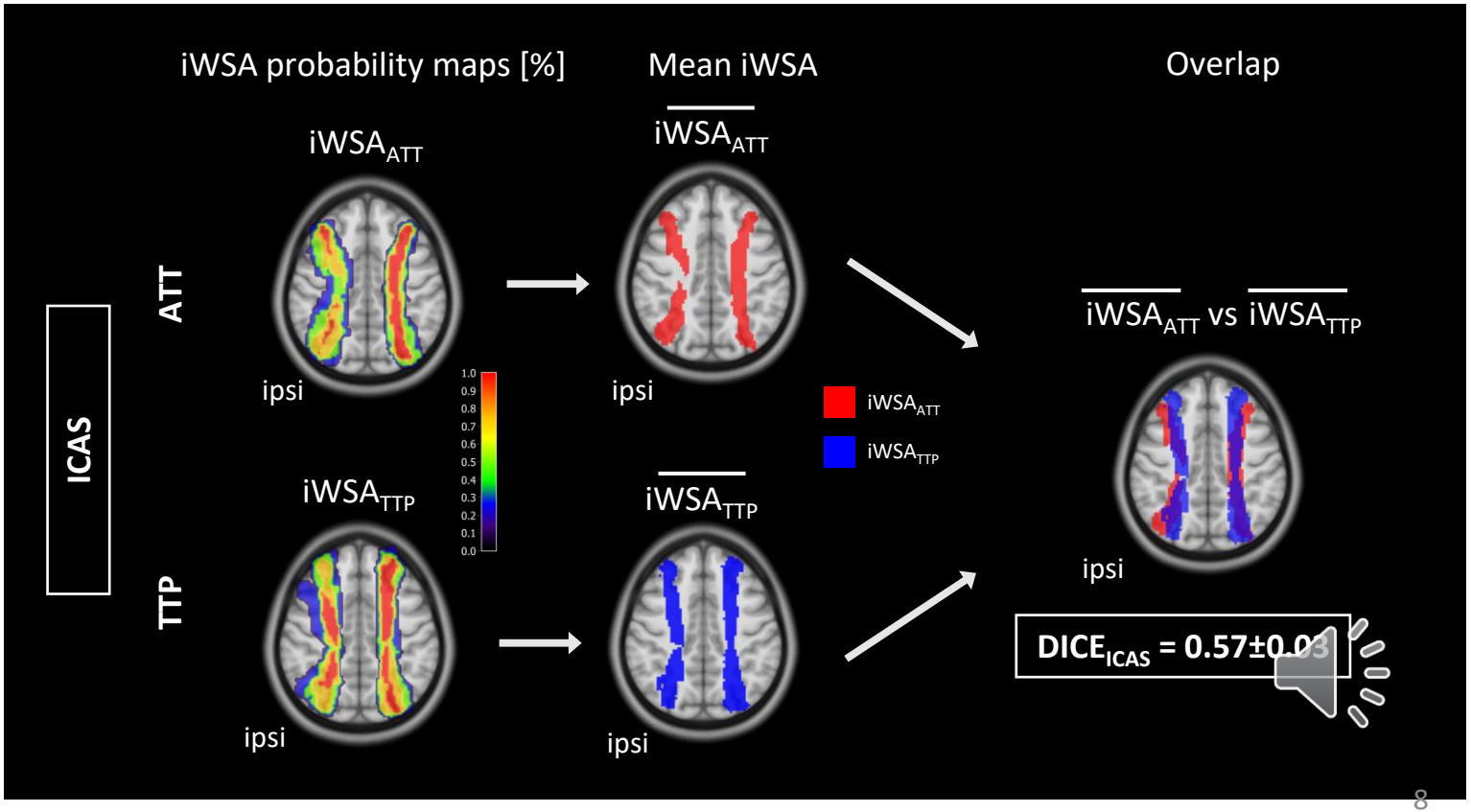
Do $iWSA_{ATT}$ and $iWSA_{TTP}$ overlap?

→ **Good agreement**



Do $iWSA_{ATT}$ and $iWSA_{TTP}$ overlap?

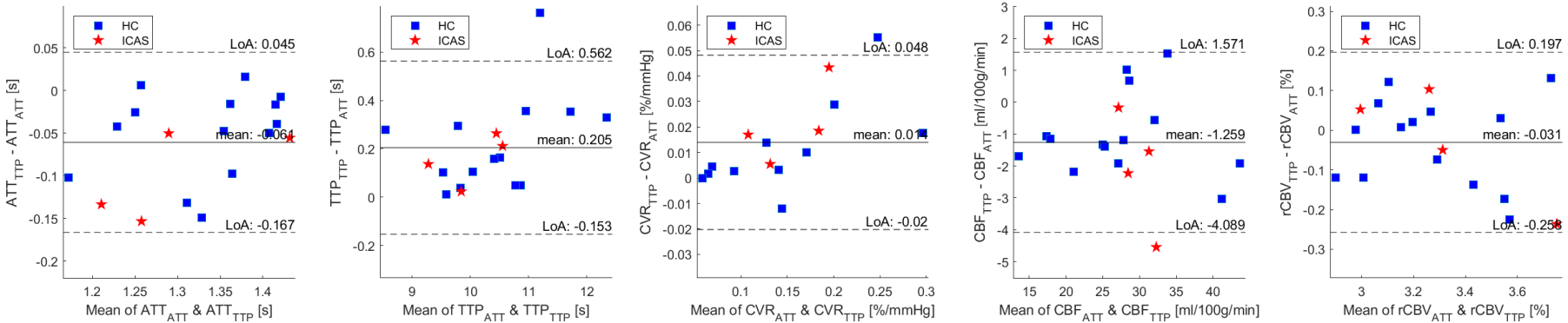
→ **Good agreement**



Do Parameter values differ systematically?

Bland Altman analyses : $iWSA_{ATT}$ vs $iWSA_{TTP}$

ATT | **TTP** | **CVR** | **CBF** | **rCBV**

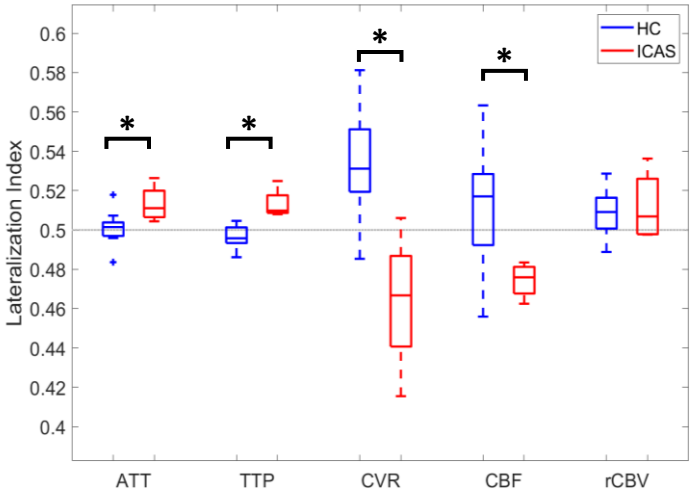


→ Bland-Altman: **No systematic differences**

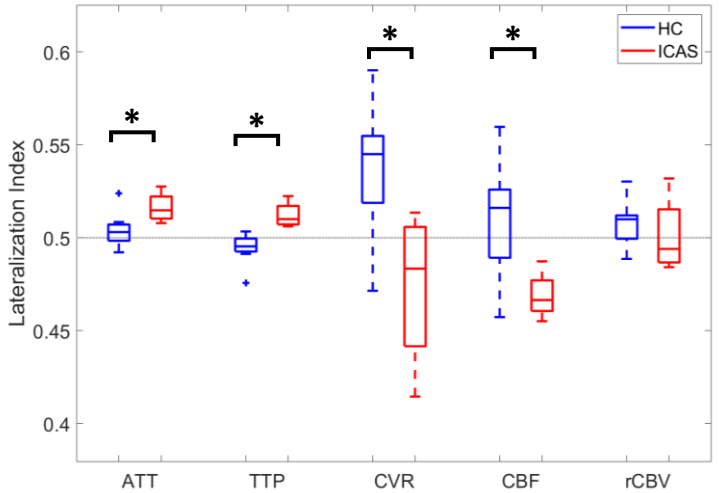
Do lateralization indices (LI) differ between $iWSA_{ATT}$ and $iWSA_{TTP}$

Group comparison: ICAS vs HC

A| ATT-based iWSA: LI



B| TTP-based iWSA: LI



→ ICAS induces **lateralization** in **ATT, TTP, CVR and CBF**

→ Results from $iWSA_{ATT}$ and $iWSA_{TTP}$ concur

Do ATT and TTP based iWSA concur?

Discussion

- Good agreement of iWSA from ATT and TTP
- Moderate DICE due to T2*-blooming in TTP-maps & rater-dependency
- Increased variability expected for ICAS[1]
- Ipsilaterally impaired hemodynamics (especially CVR) in ICAS agrees with existing literature[1,2]

Summary

- iWSA can reliably segmented from ATT-maps
- ATT-based iWSA revealed impaired hemodynamics including clinically promising CVR[4]
- ATT-based iWSAs useful for non-invasive longitudinal mapping of vascular border-zones in ICAS and other CVD such as Moyamoya

1: Kaczmarz, Neuroradiology, 2018 2: Kaczmarz, JCBFM, 2021 3: Göttler, JCBFM, 2020 4: Donahue, JCBFM, 2018

Klinikum rechts der Isar
Technical University of Munich

Thank you for your attention!

We want to highly appreciate the support by:

German Research Foundation (DFG)
Ev. Studienwerk Villigst