

Observing Skill Acquisition "In The Wild"

Gal Ben-Zvi¹, Yaniv Assaf^{1,2}

¹ Sagol School of Neuroscience, Tel-Aviv University, Tel-Aviv, Israel

² Department of Neurobiology, Faculty of Life Sciences, Tel Aviv University, Tel Aviv, Israel



Background

- ❖ Neuroplasticity refers to changes being introduced to the brain's structural and functional properties in response to experiences throughout life.
- ❖ Provided that neuroplasticity is a complex process, describing different aspects of it requires that researchers focus on specific, confined, and easily-defined tasks.
- ❖ The detachment of the learning processes from how they occur in real life raises an interesting question: Can we observe neuroplasticity via MRI even when it occurs as part of everyday life?
- ❖ This study utilizes diffusion MRI (dMRI) to describe neuroplasticity in terms of changes to Mean Diffusivity (MD) as observed in real-life, naturalistic environments.

MRI protocol

- ❖ 3T Siemens MRI Scanner MAGNETOM Prisma.
- ❖ Anatomical high-resolution T1w scan with TR/TE=1750/2.6ms, 1x1x1mm³ resolution.
- ❖ Multi-shell diffusion MRI:
 - 4 b-value shells (0,1000,2000 and 4000).
 - 83 gradient directions
 - TR/TE=3200/95ms, $\Delta/\delta=31/18$ ms.
 - 1.6x1.6x1.6mm³ resolution.

Participants

- ❖ **Naïve** participants are such that have no experience in the skill they are about to learn, **denoted as n**.
- ❖ **Control** participants are skilled individuals in the above mentioned skill, **denoted as c**.
- ❖ 33 participants divided as follows:

Condition	Climbing		BJJ	
	n	Age	n	Age
Naïve	14	30.23 ± 3.19	9	32.89 ± 8.10
Control	10	28.80 ± 5.75	-	-

Design

- ❖ Participants were scanned before and after an **8 weeks period**.
- ❖ During this period of time, they either **learned** (naïve group) or **practiced** (control group) **climbing** or **Brazilian Jiu-Jitsu (BJJ)**.
- ❖ Average **MD** was calculated per ROI of the Brainnetome atlas.
- ❖ The following effects were included in the statistical design:
 - **"Session"** - after vs. before for the naïve groups ($n_2 \rightarrow n$).
 - **"Group"** - control vs naïve. ($c \rightarrow n$)
 - **"Interaction"** - difference in the change in MD between the "naïve" and "control" groups. ($n_2 - n \rightarrow c_2 - c$).
- ❖ Fig. 1 describes the study's design and group's notation.

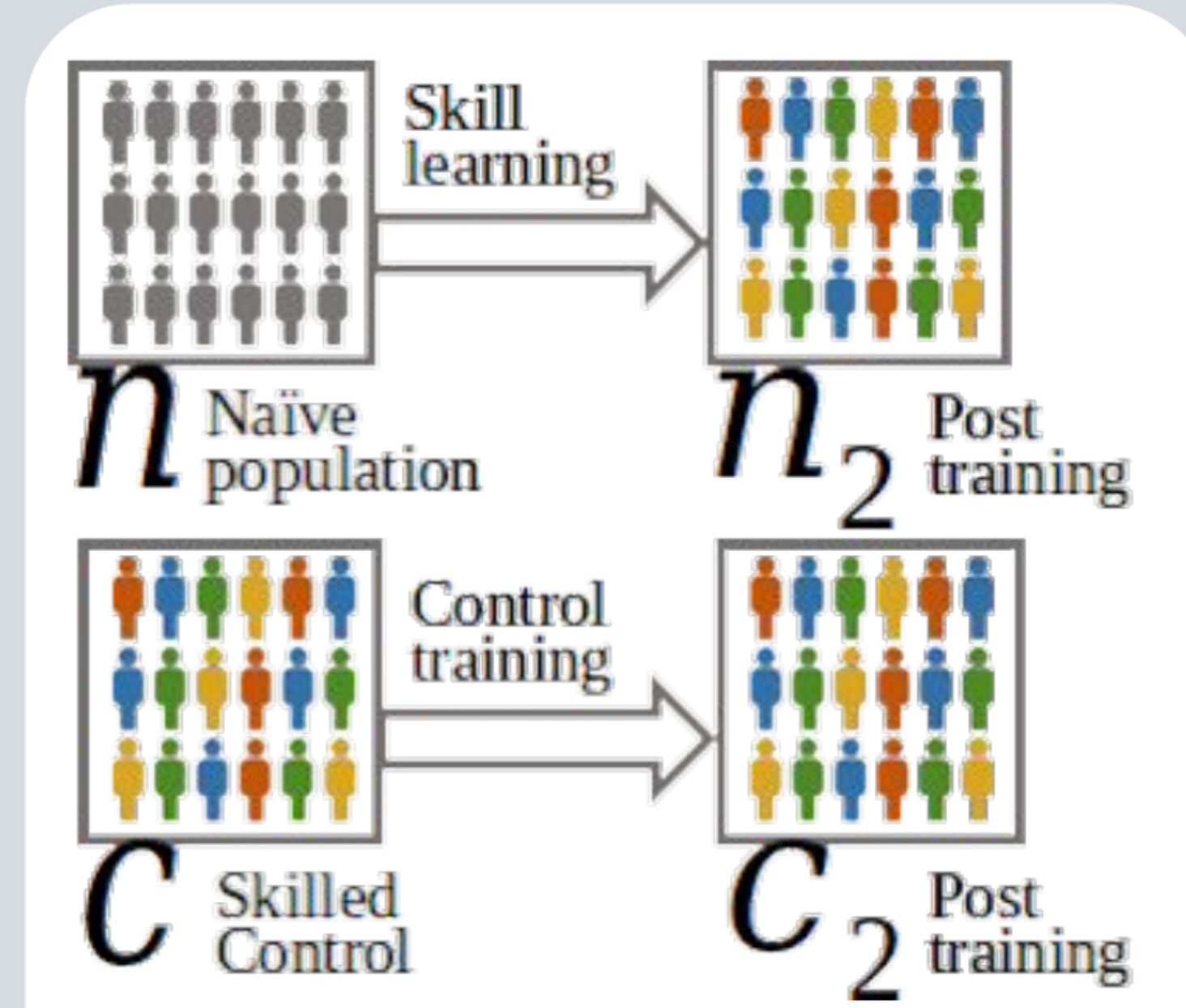


Figure 1: Study's design and group's notations.

MRI-sensitive Neuroplasticity in real life

- ❖ Region-wise paired and two-sample t-tests were performed to identify changes to MD that were significant in relation to the **"session"** and **"group"** effects.
- ❖ For simple interpretation of the **"interaction"** effect, we performed two-sample t-tests using within-subjects' relative change as the dependent variable.
- ❖ Fig. 2 describes the above-mentioned effects for the **climbing** cohort.

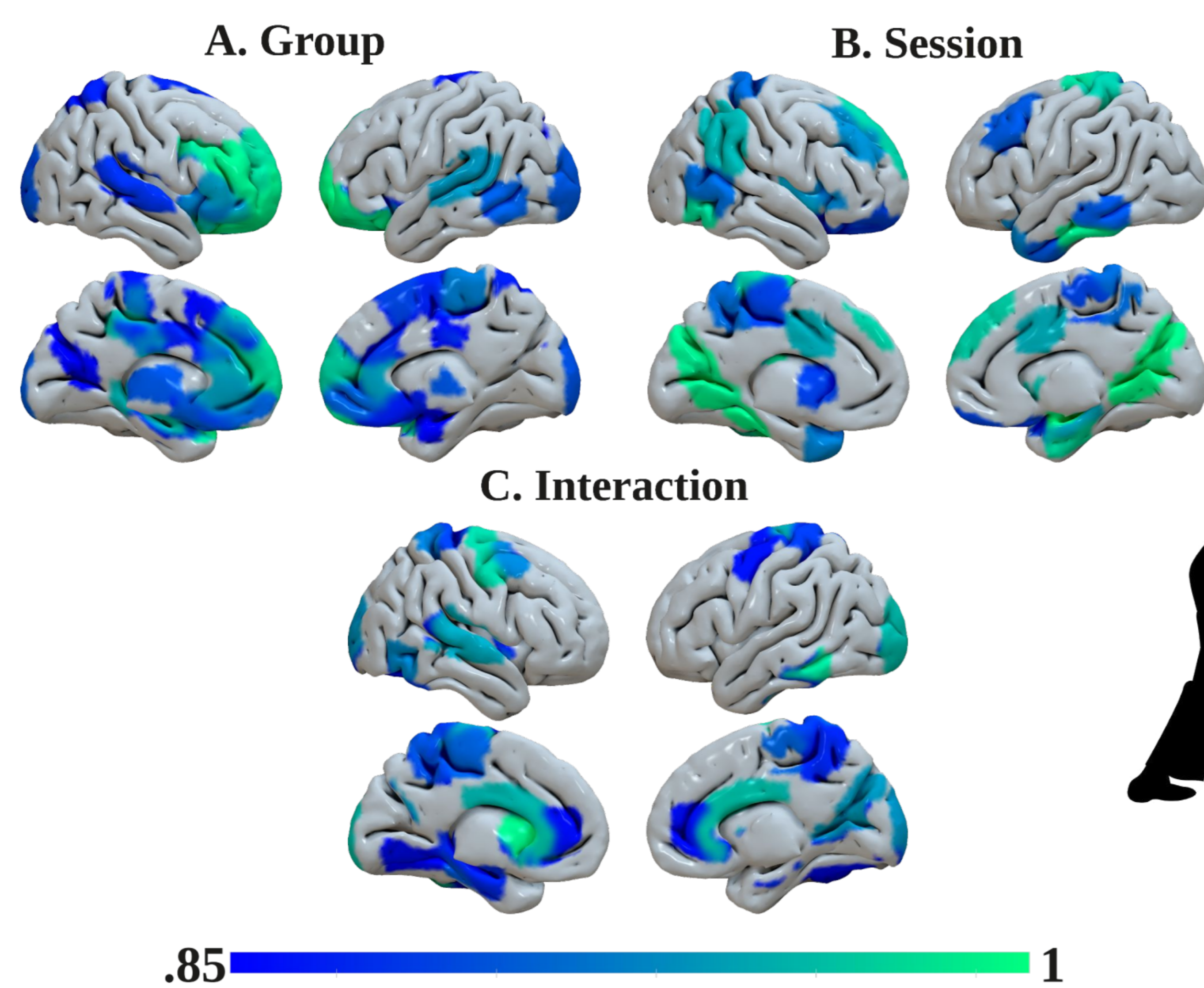


Fig. 2: Effects of climbing as measured via MD. **(A and B)** Changes to MD associated with the **"Group"**, **"Session"**, effects accordingly. **(C)** Changes associated with the **"Interaction"** effect, describing differences between acquiring a skill and practicing it. Values are presented as 1-p value.

Same same, but different

- ❖ To account for any sport-specific mechanism of neuroplasticity, we conducted region-wise two-sample t-tests using within-subjects' relative change in MD, between naïve participants learning **climbing** and those learning **BJJ**.
- ❖ Fig. 3 suggests that while the spatial distribution of changes associated with the acquisition of both sports largely overlap, the **"interaction"** between them revealed differences in the change of structural properties that accompanied the learning process.

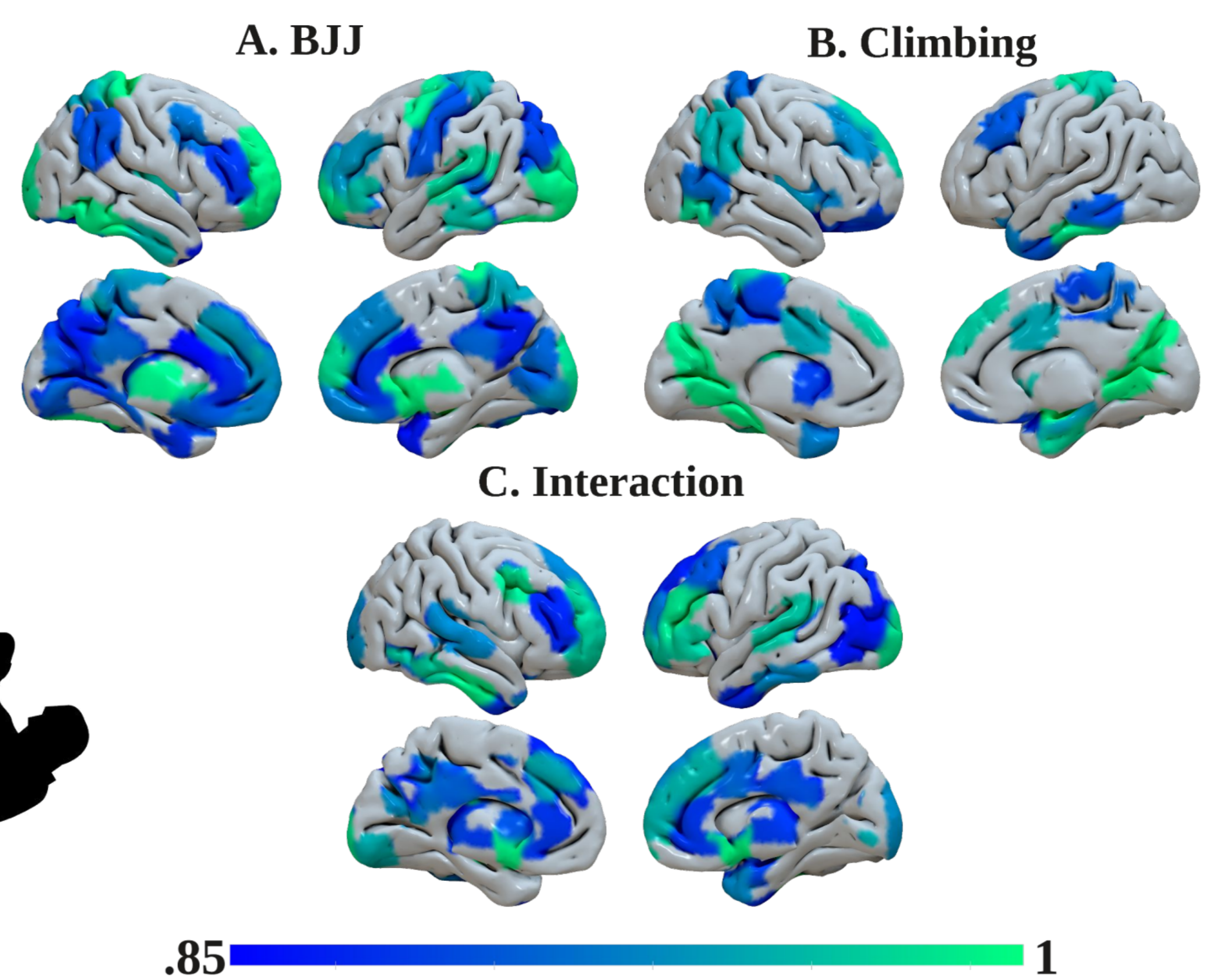


Fig. 3: Structural manifestation of different skill-learning. **(A and B)** Changes in MD associated with the **"Session"** effect (skill learning) of BJJ and climbing accordingly. **(C)** Changes associated with the **"Interaction"** effect, describing differences between the acquisition of the different sports. Values are presented as 1-p value.

Discussion

- ❖ Results derived from the initial, preliminary cohort of this study suggest that **dMRI is sensitive** enough to capture changes being introduced to the brain's structural properties following the **acquisition of complex motor skill** such as climbing and BJJ.
- ❖ although the separately-examined "session" effects of the two different sports largely overlap in terms of spatial distribution, the interaction effect between the two revealed a significant change in the structural manifestation of acquiring the **different complex motor skills**.
- ❖ Plasticity designs occurring "in the wild" yield **larger variability** in the effects being measured, therefore require **larger sample** sizes to detect them.