Vulnerability of inter-hemispheric functional connectivity in the aging sensorimotor network

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Introduction:

The aging process is accompanied by a functional reorganization process [1], e.g. hemispheric asymmetry reductions [2]. Focusing on the older adult population, characterized by a high inter-individual variability in brain-phenotype relations, resting state functional connectivity (FC) of the sensorimotor network (SMN) was proven to be particularly important: Decreases in within-NW FC were found to mediate the age-related cognitive performance decline [3]. However, whether these age-related differences in FC of the SMN would be related to the major aging theories by e.g. showing inter-hemispherical differences remains unclear and is therefore focus of the current study.

Methods:

We analyzed FC of 636 older adults (55-87 years, 324 men, 92% right-handed) from the population-based

1000BRAINS study [4]. For each participant, 300 resting-state functional EPI images were acquired (3T Siemens Tim-TRIO). FC was defined by Pearson's correlations between region's BOLD fluctuations. 400 nodes within seven functional NW were defined (visual (VN), SMN, dorsal-attention (DAN), ventral-attention (VAN), frontoparietal (FPN) and DMN [5]) and partial correlations were calculated between each edge and age (significant at $p < .05$, corrected for sex and education). Based on these correlation matrices, we separated edges into those connecting regions within the SMN (intra-NW) on the LH, RH and across hemispheres. Inter-NW FC comprise connections between regions of the SMN with other NWs. Here, we also differentiated between edges within the RH or LH (i.e. SMN LH-regions to other NW LH-regions) and those across hemispheres (i.e. SMN LH-regions to other NW RH-regions). For each intra-NW and inter-NW set of connections we estimated the mean correlation and the proportion of changing edges. Differences between RH and LH for mean correlations and the proportion were statistically compared [6,7] (significant at $p < .05$, Bonferroni-corrected).

Results:

While the mean correlations of FC between regions remained stable, significant differences pertain to the proportion of connections within the SMN as well as with other NW: 70% of all connections within the SMN show age-related decreases. Thereby, the set of regions within the RH show more decreases as compared to those within the LH ($z=-8.64$, $p<.001$). However, most decreases occur between left and right hemispheric parts of the SMN ($z=-7.53$, $p<.001$). Inter-NW FC between the SMN and other NW show decreases as well as increases: While decreases particularly pertain to connections of the SMN with the VN, DAN and VAN, increases rather affect connections between the SMN and the LN, FPN and DMN (see Figure). FC decreases are more pronounced within the RH ($z=-23.95$, $p<.001$), while increases are comparable for both hemispheres ($z= 0.92$, $p=.36$), the latter showing more increases within than across hemispheres ($z=-7.43$, $p<.001$).

Conclusions:

Age-related FC decreases within the SMN were more pronounced in the RH as compared to the LH. This was particularly shown for the inter-NW FC of regions spanning the dorsolateral stream (i.e. VN, SMN and DAN) associated with eye-hand coordination of contralateral (i.e. left) body parts [8]. The current results therewith support two major functional brain aging theories: First, the right hemi-aging model [9] suggesting right hemispheric brain parts to decline earlier than left hemispheric parts. Second, given the majority of people investigated being right-handed, SMN regions within the LH might be predominantly involved in eye-hand coordination. Here, stronger decreases in the RH underpin the idea of the use-it-or-lose-it principle [10]. Finally, while age-related intra-NW FC decreases of the SMN might be driven by an inter-hemispheric decoupling, FC increases were mainly present for inter-NW FC within hemispheres hinting at compensatory attempts to maintain SMN functioning as stable as possible. Hence, the current results emphasize an inter-hemispherically different vulnerability of the SMN in older adults.

Lifespan Development:

Aging [1]

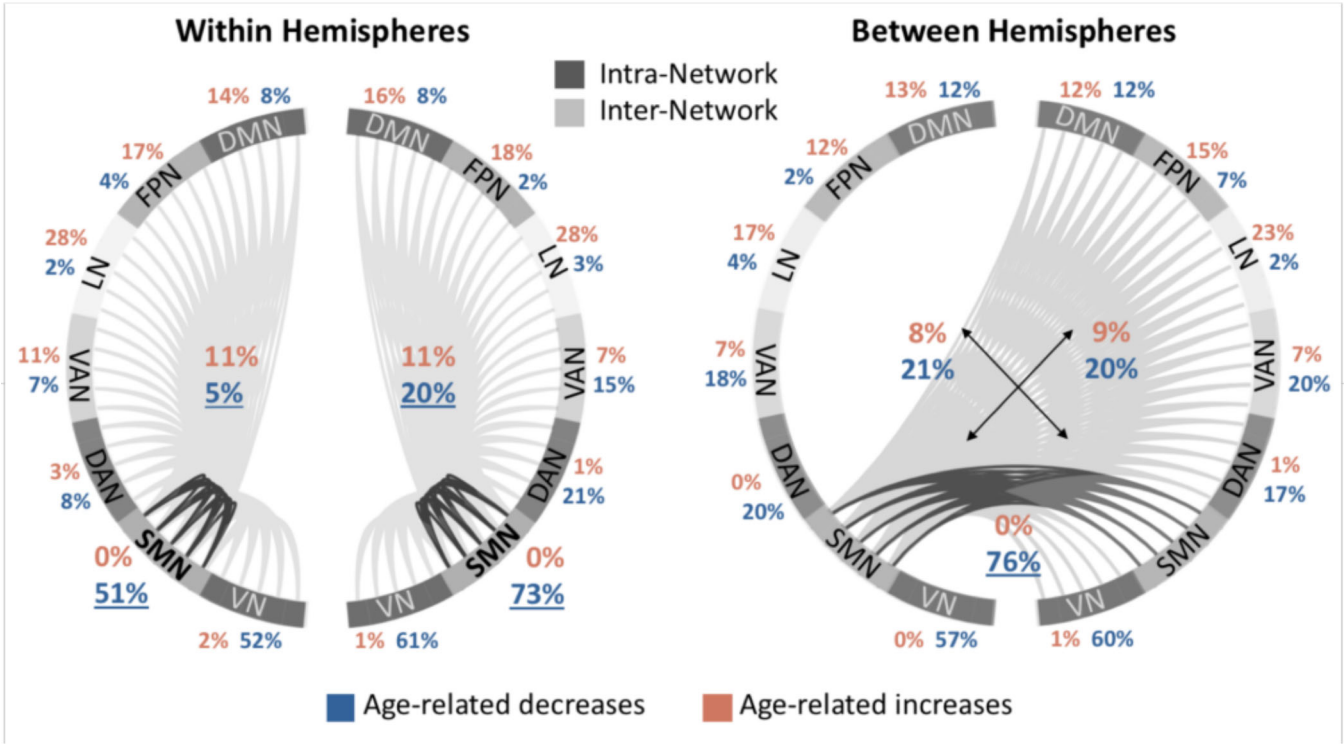
Motor Behavior:

Visuo-Motor Functions [2]

Keywords:

Aging
FUNCTIONAL MRI
Motor
Other - Connectivity

[1|2]Indicates the priority used for review



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No

Please indicate below if your study was a "resting state" or "task-activation" study.

Resting state

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

Healthy subjects

Was any human subjects research approved by the relevant Institutional Review Board or ethics panel? NOTE: Any human subjects studies without IRB approval will be automatically rejected.

Yes

Was any animal research approved by the relevant IACUC or other animal research panel? NOTE: Any animal studies without IACUC approval will be automatically rejected.

No

Please indicate which methods were used in your research:

Functional MRI

For human MRI, what field strength scanner do you use?

3.0T

Which processing packages did you use for your study?

SPM
FSL

Provide references using author date format

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