Investigating the association between brain network connectivity and attention following acquired brain injury: A systematic review of structural and functional measures

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Introduction

- Acquired brain injury (ABI) = injury to the brain since birth, where traumatic brain injury (TBI) and stroke are the most common injuries[1]
- Cognitive complaints are common following ABI and may reflect changes brain network connectivity[2]
- Attention problems are one of the most common cognitive complaints[3]
- The relationship between brain network disruption and attention dysfunction is unclear

Aim: to systematically review the relationship between brain connectivity and attention following ABI

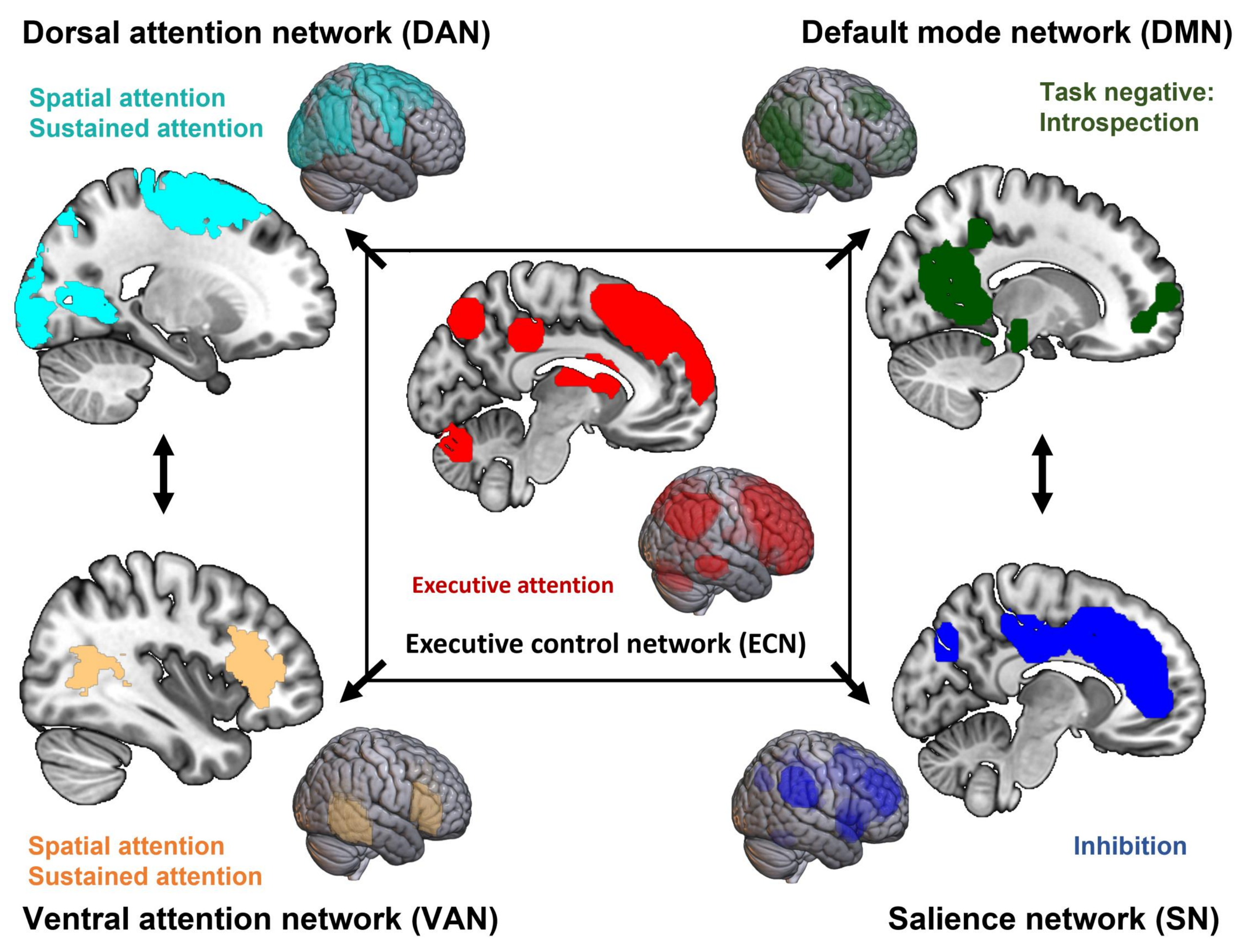

Figure 1: Core attention networks and predominant attention-related functions

Methods

Inclusion and exclusion criteria

- Included: pts of any age with ABI and measured brain connectivity at any time post-injury
- Excluded: involved non-human participants; n=1 studies; developmental/progressive brain injury; brain tumor; no association between attention and brain connectivity reported

Screening

- PRISMA guidelines[4]
- Covidence used for T&A screening, full text screening (two reviewers)

Quality assessment

- AXIS tool[5] – cross sectional studies (two reviewers)
- Studies rated out of 20 points

Data extraction

- n=43 articles included in final analysis

Data synthesis

- Meta-analysis not possible
- SWiM guidelines[6] – grouped data by (1) injury type, (2) neuroimaging modality, (3) attention domain, (4) age group, (5) recovery phase, (6) brain network

Results

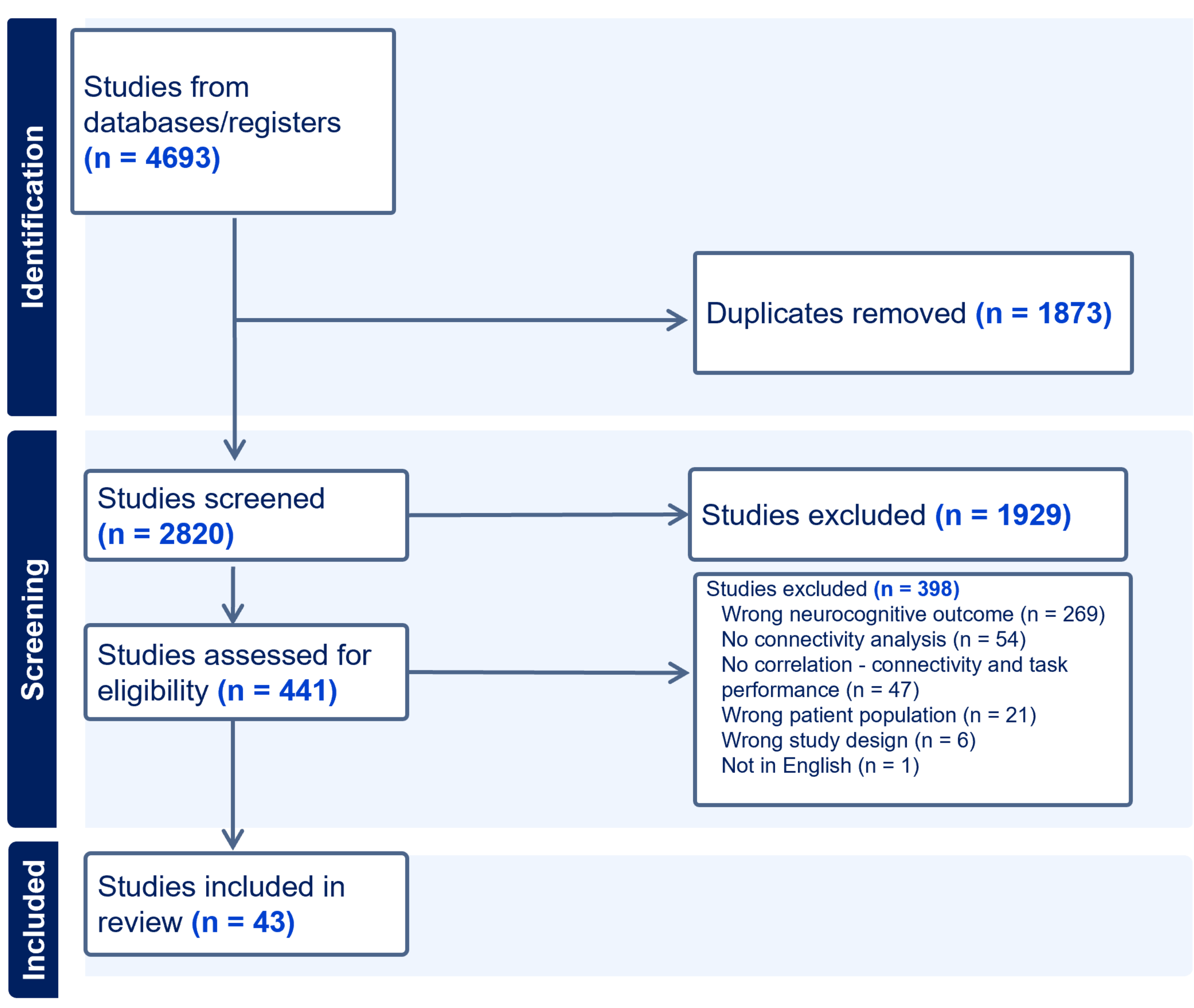

Figure 2: PRISMA flow diagram

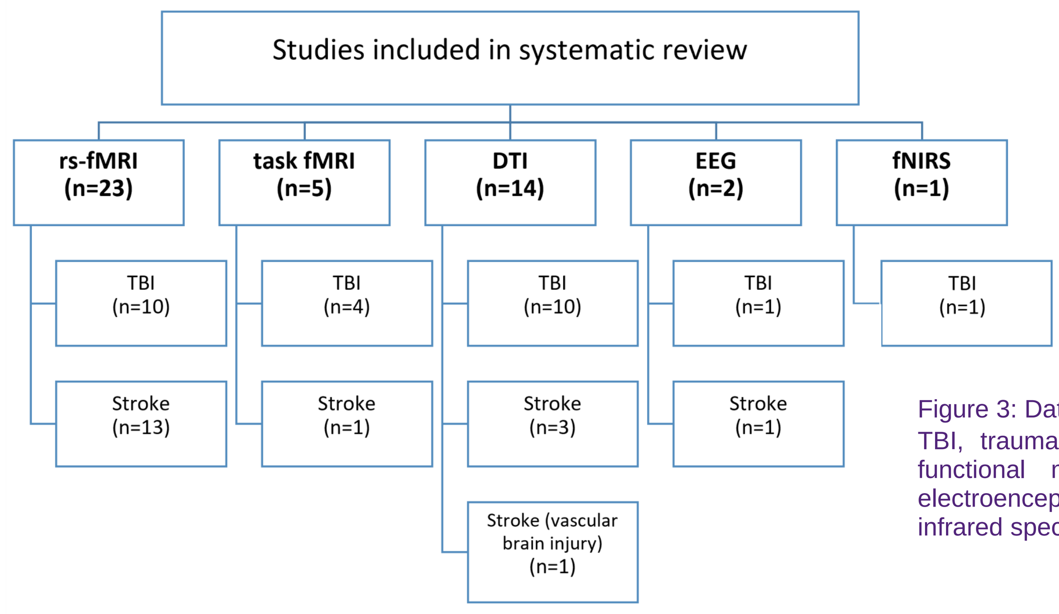

Figure 3: Data synthesis structure
TBI, traumatic brain injury; rs-fMRI, resting-state functional magnetic resonance imaging; EEG, electroencephalography; fNIRS, functional near-infrared spectroscopy; DTI, diffusion tensor imaging

Main findings: Attention-related connectivity following ABI

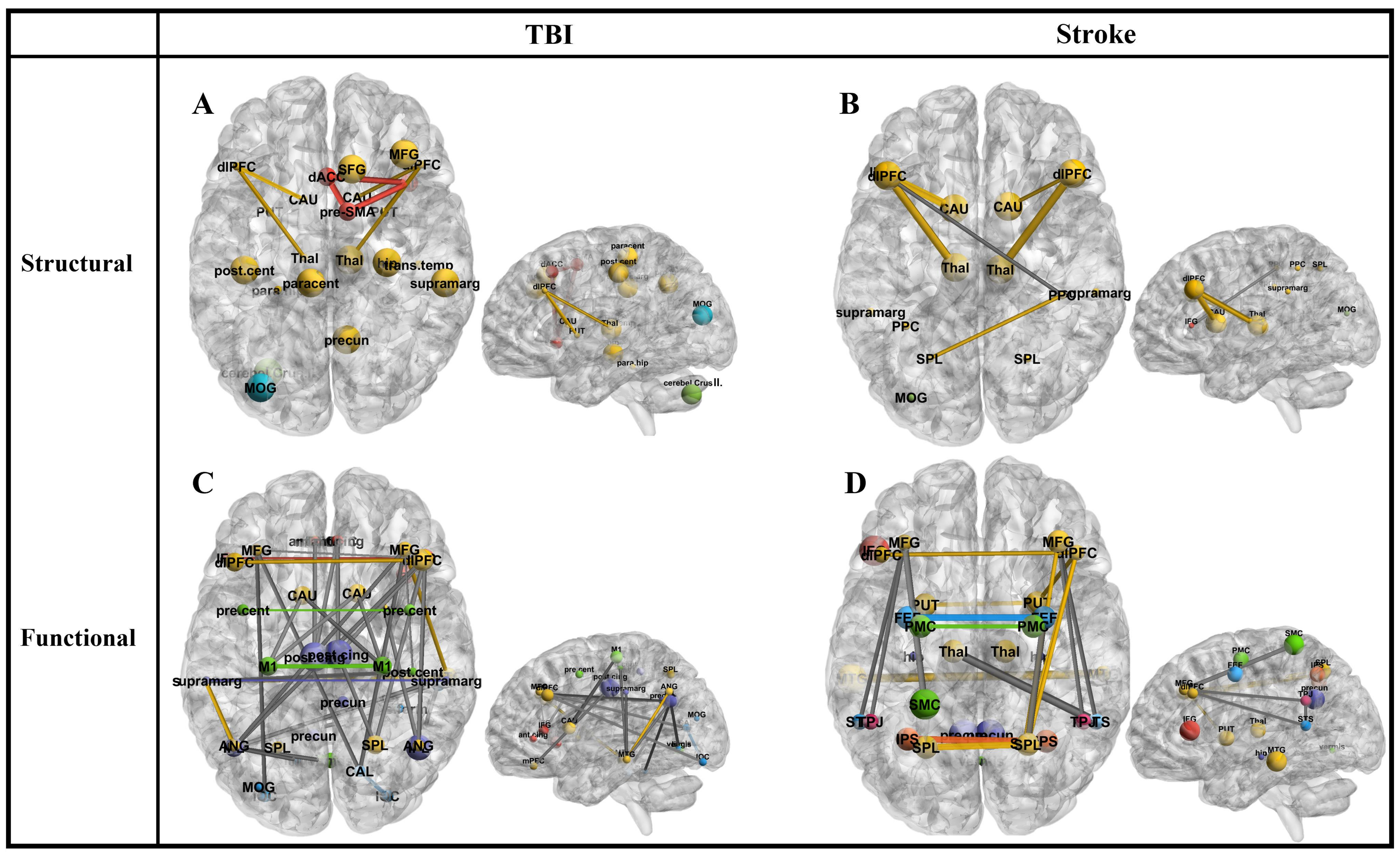

Figure 4: A graphical representation of significant correlations reported between structural or functional connectivity and attention within and between brain regions following TBI and stroke. Node and edge size relate to effect size, where larger nodes and thicker edges represent reporting of region/s in a greater number of studies. Node colours represent the related attention networks: yellow, ECN; indigo, DMN; red, SN; orange, DAN; pink, VAN; green, somato-motor network; blue, visual network. Coloured edges represent within-network connectivity, whereas grey edges represent between-network connectivity. Direction of correlation (positive or negative) and attention domain not shown for parsimony. Left side of graphic represents left side of brain.

Following **TBI**, greater attention was associated with:

- **greater** structural global and local efficiency within and between the **executive network (ECN)**, **salience network (SN)** and **default mode network (DMN)**
- **greater** fc within and between **ECN and DMN**

Following **stroke**, poorer attention was associated with:

- **lower** structural connectivity within **ECN**
- **greater** fc between task positive networks (**ECN**, **DAN**, **SN**, **VN**)

Differences across age

- Attention-related **structural connectivity** differed across pediatric (n=7) and adult studies (n=36) (in TBI and stroke)
  - **Pediatric:** decreases in structural network segregation strongly associated with greater attention
  - **Adult:** greater structural network efficiency strongly associated with greater attention
- Attention-related **functional connectivity** trends were similar across the lifespan

Differences across recovery stage

- Recovery from mild **TBI** associated with normalization of **DMN** activity alongside improved attention
- Recovery from **stroke** associated with greater connectivity within **DAN** and greater segregation between **DAN** and **DMN**, alongside greater attention

Conclusions and implications

- In adult TBI, **DMN interference** is related to greater attention
- In adult stroke, **greater DAN connectivity** is related to greater spatial attention
- In childhood TBI, **decreased structural segregation** is related to greater attention
- **Attention improvement in TBI and stroke recovery** is associated with **DMN normalisation**
- Systematic review **limited by biased literature**: predominantly ROI-based approaches and mostly significant correlations between attention and connectivity reported

Recommendations

- Thorough reporting of patient clinical details
- Openly-accessible data and standardised neuroimaging pipelines
- Standardised assessment of attention following injury
- Combine functional neuroimaging with non-invasive brain stimulation
- More EEG and fNIRS connectivity to advance use at point-of-care

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