A new approach to examining the role of white matter tracts in language disorders

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Introduction

We investigated the feasibility of a new processing approach for extraction of fractional anisotropy (FA) values from white matter tracts in individuals with stroke lesions using standard atlases.

Main features of the approach:

1. Transform of individual FA map to T1 space;
2. Computation of the transform from T1 to MNI;
3. Application of inverse transform from previous step for tracts chosen from atlas in MNI space;
4. Use of transformed tracts as ROI for extraction of FA values in T1 space.

Acquisition parameters

DW data: acquired with a 1.5T Siemens Avanto, acquisition matrix=70x70; FOV=192x192 mm2; TR/TE=6000/95 ms; b=1000 s/mm2; 20 directions, 2 repetitions; 2 b=0 scans; slice thickness=2.7mm, voxel 2.7x2.7x2.7mm

Participants

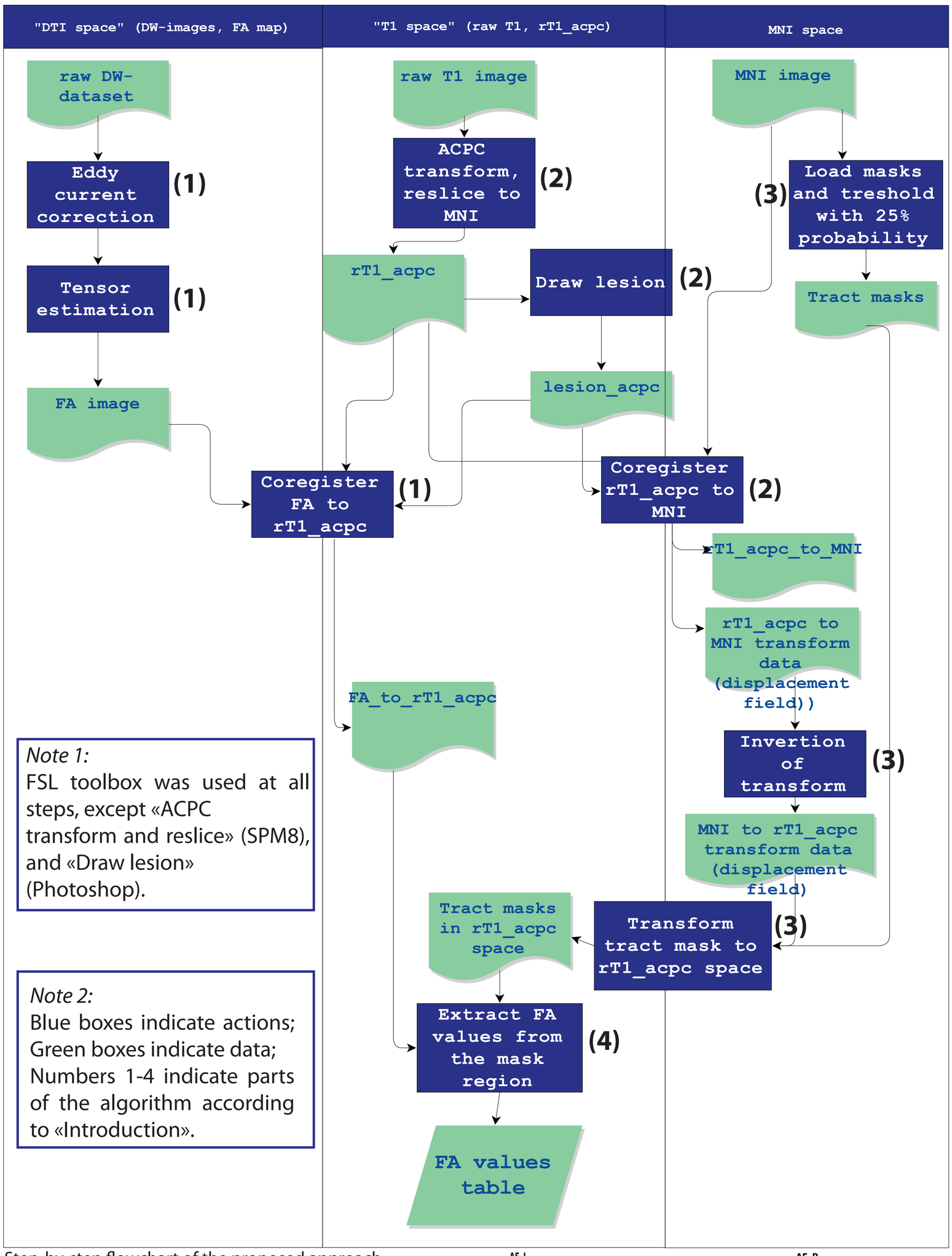
37 individuals with different types of aphasia due to stroke;
9 age-matched healthy volunteers;
all participants were right-handed.

Results

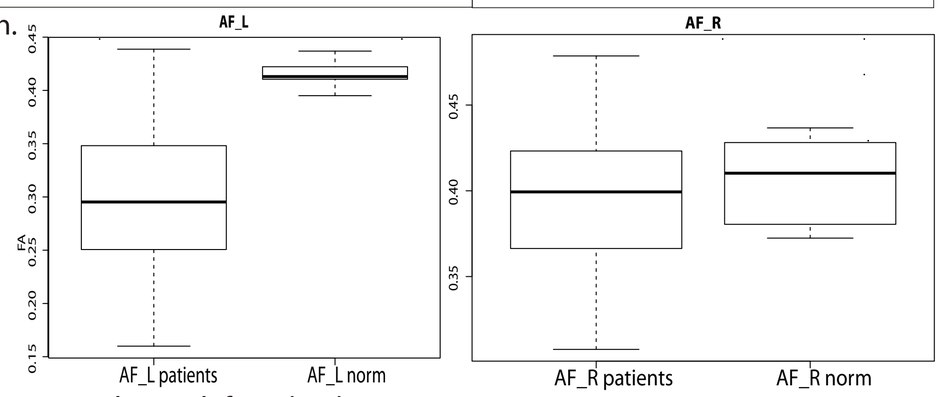
We investigated the integrity of Inferior fronto-occipital fasciculus (IFOF) and Arcuate fasciculus (AF) tracts using the FA metric.

Tract	Mean value (Standard deviation)		25%-75% Quantile		Mann-Whitney p-value
	Aphasia	Controls	Aphasia	Controls	
IFOF_Left	.309 (.055)	.385 (.023)	.267 - .358	.367 - .399	< .0001
IFOF_Right	.365 (.027)	.390 (.017)	.349 - .381	.377 - .401	.0083
AF_ Left	.286 (.087)	.420 (.016)	.232 - .343	.415 - .428	< .0001
AF_ Right	.395 (.039)	.405 (.027)	.366 - .423	.381 - .428	.4285

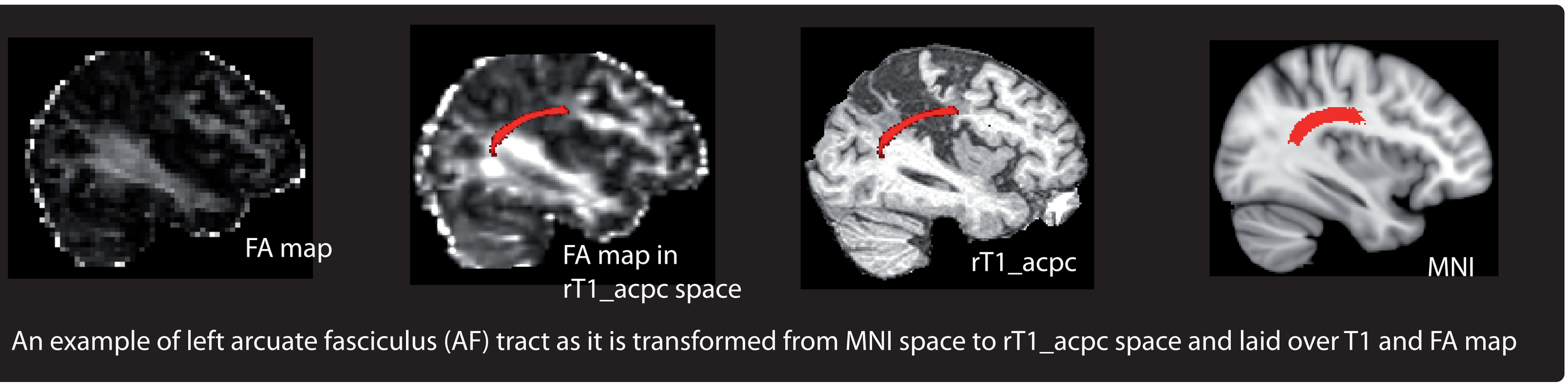
- Healthy controls had significantly higher mean FA values in both left and right IFOF tracts and left AF. No significant differences were found for the right AF.
- In aphasia group the right hemisphere tracts had significantly higher mean FA values. For the control group no significant differences between the integrity of the tracts in two hemispheres were found.



Step-by-step flowchart of the proposed approach.



FA values in left and right AF.



An example of left arcuate fasciculus (AF) tract as it is transformed from MNI space to rT1_acpc space and laid over T1 and FA map

1. The method resulted in reliable isolation of tracts in native space for individuals with various lesions, enabling extraction of FA values for the whole tract.

2. The method can be applied for investigating tract integrity of individuals with focal brain lesions, when reconstruction of the tract is not possible due to damage and more traditional techniques, like TBSS, cannot be applied.

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