Supplementary Material

1 Complementary Analysis: Registration Settings Testing

1.1 Detailed Image registration benchmark

As described in section 2.4, two frameworks were used to capture the dynamic changes of inter-hemispheric brain asymmetry. These required three different types of image registrations: direct fetal to neonatal registration, fetal to mid-template and neonatal to mid-template registration. Each of these consists of a linear and a subsequent non-linear step to ensure accurate anatomical correspondence between the structures. As a next step in our analysis, we evaluated the accuracy of a popular image registration tool with various, commonly used settings.

1.1.1 Linear registration

For the linear registration, we used the linear registration algorithm implemented in the FSL software (flirt) (Jenkinson et al. 2002) and the ANTs software (Tustison et al. 2021). All linear registrations resulted in affine transformations with 12-degrees of freedom. To find a suitable linear registration for our study, the transformation settings in ANTs python implementation 'antspy' as well as settings based on recommendations for the terminal use of the ANTs toolbox were tested. All registrations were run separately with and without masking of the cost function. For the masking, we created two different types of binary masks, one based on the image segmentations directly and an eroded version of this brain mask (generated using fslmaths). We tested the results of an eroded masking strategy as this minimizes the effect of the most outer image intensities which still could contain darker voxels after skull stripping and may create artificial boundaries to the image and affect the alignment and scaling of the linear registration. Detailed information on the various configurations of the linear registrations used can be found in the **Supplementary Table 1**.

1.1.2 Deformable image registration

For the deformable image registration we explored two non-linear registration methods implemented in the ANTs software (Tustison et al. 2021): the Symmetric Normalization (SyN) transformation model (Avants et al. 2008) and the time-varying diffeomorphism with mean square metric. Since there is no recommendation on the optimal configuration for the large deformation that our study might require, we evaluated different combinations of pre-processing options, optimization settings and cost metrics. In this series of tests, we only considered settings that used the binary mask generated from the segmentation as this was also the mask used in the later steps of the asymmetry analysis.

Detailed information on the various settings of the deformable image registrations used can be found in the **Supplementary Table 2.**

1.1.3 Evaluation of registration accuracy

Registration accuracy was tested using two volumetric (image segmentation-based) accuracy metrics and one anatomical landmark-based metric. The rationale for this was to obtain a set of quantitative measurements of accuracy that then can be ranked based on a set of defined rules to find the most suitable registration settings for the entire dataset.

1.1.3.1 Registration evaluation ranking

To rank the different registration algorithms and settings, we used the ChallengeR tool (Wiesenfarth et al. 2021). This R package was originally designed to rank the performance of algorithms in e.g., image segmentation challenges. Similarly, different registration settings were ranked on their performance of a task, e.g., the distance of a specific landmark to its reference. For each evaluated registration step and metric, a ranking was performed using the ranking scheme aggregate using function "mean", then rank. Next, for each registration step, the results of each metric ranking were summed, and an overall winner was defined. To take into consideration that the volume difference and Dice coefficient both reflect volumetric measures, we assigned a weight of 0.5 to them, so that the landmark-based metrics (distance measure) contributed equally to the summed ranking score:

$$summed\ ranking\ score = 0.5 * (consensus\ rank\ dice + consensus\ rank\ volume\ difference) + consensus\ rank\ Landmarks$$

Supplementary Table 1: Linear registration settings

Naming	**call**
Terminal/bash CC	antsRegistration --dimensionality 3 --float 0 \ --output [${warp},${image}] \ --interpolation Linear \ --winsorize-image-intensities [0.005,0.995] \ --use-histogram-matching 1 \ --initial-moving-transform [${template},${subj},1] \

	--transform Rigid[0.1] \ --metric CC[${template},${subj},1,2,Regular,0.25] \ --convergence [1000x500x250x100,1e-6,10] \ --shrink-factors 8x4x2x1 \ --smoothing-sigmas 3x2x1x0 \ --transform Affine[0.1] \ --metric CC[${template},${subj},1,2,Regular,0.25] \ --convergence [1000x500x250x100,1e-6,10] \ --shrink-factors 8x4x2x1 \ --smoothing-sigmas 3x2x1x0 \ -x [${maskfix},${maskmoving}] --verbose 1 (see https://github.com/ANTsX/ANTs/wiki/Anatomy-of-an-antsRegistration-call)
Terminal/bash MI	antsRegistration --dimensionality 3 --float 0 \ --output [${warp},${image}] \ --interpolation Linear \ --winsorize-image-intensities [0.005,0.995] \ --use-histogram-matching 1 \

	--initial-moving-transform [${template},${subj},1] \ --transform Rigid[0.1] \ --metric MI[${template},${subj},1,32,Regular,0.25] \ --convergence [1000x500x250x100,1e-6,10] \ --shrink-factors 8x4x2x1 \ --smoothing-sigmas 3x2x1x0 \ --transform Affine[0.1] \ --metric MI[${template},${subj},1,32,Regular,0.25] \ --convergence [1000x500x250x100,1e-6,10] \ --shrink-factors 8x4x2x1 \ --smoothing-sigmas 3x2x1x0 \ -x [${maskfix},${maskmoving}] --verbose 1 (see https://github.com/ANTsX/ANTs/wiki/Anatomy-of-an-antsRegistration-call)
antspy linear: Affine, TRSAA, Similarity	#(for transform in ["Affine", "TRSAA", "Similarity"]:) ants.registration(fixed = fixed, moving = moving, mask=mask_temp, type_of_transform= transform)
antsAI	antsAI -d 3 \

	-t Rigid[0.1] \ -m GC[${fixed}, ${moving}] \ -t Affine[0.1] \ -m GC[${fixed}, ${moving}] \ -m Mattes[${fixed}, ${moving}, 32, None, 0,3] \ -x [${fixedImageMask}, ${movingImageMask}] \ -o ${linear_registration} -v 1;
FSL flirt	flirt -in ${moving} -ref ${fixed} -omat ${linear_registration} -out ${outputfile}; \ ./c3d-0.8.2-Linux-x86_64/bin/c3d_affine_tool -ref ${fixed} -src ${moving} ${linear_registration} -fsl2ras -oitk ${linear_registration::-4}_flirt2ants.txt'

Supplementary Table 2: Nonlinear registration settings

type_of_transform	syn_metric	syn_sampling	reg_iterations (reg_iter, registration iterations)
'SyNOnly'	MI	32	(40, 20, 0) (antspy default) (100, 70, 50, 20)
'SyNOnly'	CC	2, 4, 6	(40, 20, 0) (antspy default) (100, 70, 50, 20)
'TVMSQ'			(40, 20, 0) (antspy default) (100, 70, 50, 20)
'TVMSQC'			(40, 20, 0) (antspy default) (100, 70, 50, 20)

RESUTLS

In **Supplementary Table 3** the top ranked and chosen linear registration strategies for the asymmetry analysis framework are shown. To linearly align the brains to their target, a TRSAA registration was ranked best for all three registration steps, however with a different masking strategy for each. Overall, the neonatal to template registration achieved better mean metric results suggesting a better linear alignment. **Supplementary Table 4** provides an overview of the highest ranked and therefore chosen registration approach for each of the three registration steps. After initial tests demonstrated that using no mask in the nonlinear step led to registration failure, we continued by only considering approaches that used the "masked" option as this was the area from where the JD is computed. For the neonatal to template registration step two settings ranked equally good, SyN algorithm with increased iterations, cross-correlation as metric and radius 2 and radius 4. Therefore radius 2, the same radius as in the fetal to template registration was chosen. The rankings for the parameter combinations are shown in **Supplementary Tables 5-10**.

Supplementary Table 3: Linear registration. For each registration step the winner of the ranking approach was chosen**.**

Registration step	**Linear Registration setting**	**Metric**	**Consensus Rank per Metric**	***Metric median and IQR***	**Metric mean and sd**
fetal to template	TRSAA eroded masked	dice	1	0.671 0.031	0.67 0.018
		volume difference	2	-0.042 0.126	0.076 0.076
		landmarks distance	5	3.28 0.56	3.239 0.572
neonatal to template	TRSAA masked	dice	4	0.649 0.066	0.65 0.039
		volume difference	1	0.024 0.105	0.068 0.068
		landmarks distance	1	2.979 0.833	3.003 0.702
fetal to neonatal	TRSAA nomask	dice	2	0.622 0.038	0.627 0.026
		volume difference	2	-0.227 0.069	-0.222 0.051
		landmarks distance	1	3.372 1.264	3.593 1.046

Supplementary Table 4: Nonlinear registration. For each registration step the winner of the ranking approach was chosen. In the registration step neonatal to template two settings ranked a tie, SyN algorithm using CC as metric and increased iterations with radius 2 and 4. As in the other registration steps radius 2 performed better, radius 2 was chosen.

Registration step	Nonlinear Registration setting	Metric	Consensus Rank per Metric	Metric median and IQR		Metric mean and sd	
fetal to template	SyN CC radius 2 iterations (100, 70, 50, 20) bleached background	dice	2	0.749	0.01	0.748	0.007
		volume difference	1	0.029	0.037	0.019	0.031
		landmarks distance	3	2.412	0.49	2.395	0.424
neonatal to template	SyN CC radius 2* iterations (100, 70, 50, 20)	dice	1	0.846	0.017	0.844	0.013
		volume difference	1	0.007	0.01	0.006	0.008
		landmarks distance	2	1.823	0.342	2.018	0.573
fetal to neonatal	SyN CC radius 2 iterations (100, 70, 50, 20) bleached background	dice	1	0.742	0.021	0.737	0.019
		volume difference	2	-0.043	0.023	-0.045	0.022
		landmarks distance	1	2.505	1.129	2.796	1.097

Supplementary Table 5: Ranking linear registration settings fetal to template

Registration setting tested	meanRanks	consensusrank	metric	summed_consesnsus_ranking	final_ranking
TRSAA_eroded_masked	1.833333	1	dice	6.5	1
TRSAA_eroded_masked	7.5	2	voldiff	6.5	1
TRSAA_eroded_masked	4.75	5	landmarks	6.5	1
TRSAA_masked	3.5	2	dice	7	2
TRSAA_masked	8.166667	8	voldiff	7	2
TRSAA_masked	3.5	2	landmarks	7	2
Affine_eroded_masked	3.5	2	dice	7	2
Affine_eroded_masked	7.666667	6	voldiff	7	2
Affine_eroded_masked	4.1875	3	landmarks	7	2
TRSAA_nomask	4	4	dice	7	2
TRSAA_nomask	7.5	2	voldiff	7	2

TRSAA_nomask	4.375	4	landmarks	7	2
Affine_masked	6	6	dice	9	5
Affine_masked	9.166667	10	voldiff	9	5
Affine_masked	3.125	1	landmarks	9	5
Affine_nomask	5	5	dice	9.5	6
Affine_nomask	7.5	2	voldiff	9.5	6
Affine_nomask	5.0625	6	landmarks	9.5	6
Similarity_eroded_masked	6.166667	7	dice	11	7
Similarity_eroded_masked	7.333333	1	voldiff	11	7
Similarity_eroded_masked	6.625	7	landmarks	11	7
Similarity_masked	7.833333	8	dice	12	8
Similarity_masked	7.5	2	voldiff	12	8
Similarity_masked	6.625	7	landmarks	12	8
Similarity_nomask	8.666667	9	dice	16.5	9

Similarity_nomask	7.666667	6	voldiff	16.5	9
Similarity_nomask	7.5625	9	landmarks	16.5	9
flirt_NA	9.166667	10	dice	21.5	10
flirt_NA	8.333333	9	voldiff	21.5	10
flirt_na	11.8125	12	landmarks	21.5	10
terminal_CC_nomask	11	11	dice	21.5	10
terminal_CC_nomask	9.666667	12	voldiff	21.5	10
terminal_CC_nomask	11	10	landmarks	21.5	10
terminal_CC_masked	11.333333	12	dice	23.5	12
terminal_CC_masked	10.5	13	voldiff	23.5	12
terminal_CC_masked	11.0625	11	landmarks	23.5	12
terminal_MI_nomask	14.666667	14	dice	26.5	13
terminal_MI_nomask	9.5	11	voldiff	26.5	13
terminal_MI_nomask	14.6875	14	landmarks	26.5	13

terminal_CC_eroded_masked	13.333333	13	dice	28	14
terminal_CC_eroded_masked	11.666667	17	voldiff	28	14
terminal_CC_eroded_masked	12.3125	13	landmarks	28	14
terminal_MI_masked	14.666667	14	dice	29	15
terminal_MI_masked	11.333333	16	voldiff	29	15
terminal_MI_masked	14.6875	14	landmarks	29	15
antsAI_masked	15.833333	16	dice	31	16
antsAI_masked	11	14	voldiff	31	16
antsAI_masked	14.75	16	landmarks	31	16
terminal_MI_eroded_masked	16.5	17	dice	32.5	17
terminal_MI_eroded_masked	11	14	voldiff	32.5	17
terminal_MI_eroded_masked	16.875	17	landmarks	32.5	17

Supplementary Table 6: Ranking linear registration settings neonatal to template

algorithm	meanRanks	consensusrank	metric	summed_consesnsus_ranking	final_ranking
TRSAA_masked	5.5	4	dice	3.5	1
TRSAA_masked	5.666667	1	voldiff	3.5	1
TRSAA_masked	5.3125	1	landmarks	3.5	1
Affine_masked	5.5	4	dice	6.5	2
Affine_masked	6.666667	5	voldiff	6.5	2
Affine_masked	5.375	2	landmarks	6.5	2
Affine_eroded_masked	6.666667	8	dice	8	3
Affine_eroded_masked	6	2	voldiff	8	3
Affine_eroded_masked	5.4375	3	landmarks	8	3
terminal_MI_nomask	4.833333	1	dice	11	4
terminal_MI_nomask	8	9	voldiff	11	4
terminal_MI_nomask	7	6	landmarks	11	4
terminal_MI_masked	5.166667	3	dice	11.5	5

terminal_MI_masked	8.666667	10	voldiff	11.5	5
terminal_MI_masked	6.625	5	landmarks	11.5	5
TRSAA_eroded_masked	7.333333	9	dice	11.5	5
TRSAA_eroded_masked	6.833333	6	voldiff	11.5	5
TRSAA_eroded_masked	6.375	4	landmarks	11.5	5
terminal_CC_masked	5	2	dice	12	7
terminal_CC_masked	7.166667	8	voldiff	12	7
terminal_CC_masked	8.0625	7	landmarks	12	7
terminal_CC_nomask	5.833333	6	dice	12.5	8
terminal_CC_nomask	6.333333	3	voldiff	12.5	8
terminal_CC_nomask	8.125	8	landmarks	12.5	8
terminal_CC_eroded_masked	6.333333	7	dice	19	9
terminal_CC_eroded_masked	9.416667	11	voldiff	19	9
terminal_CC_eroded_masked	9.125	10	landmarks	19	9

terminal_MI_eroded_masked	7.833333	10	dice	21.5	10
terminal_MI_eroded_masked	12.666667	15	voldiff	21.5	10
terminal_MI_eroded_masked	9.0625	9	landmarks	21.5	10
Similarity_eroded_masked	11.666667	11	dice	23	11
Similarity_eroded_masked	6.333333	3	voldiff	23	11
Similarity_eroded_masked	13.5625	16	landmarks	23	11
Affine_nomask	11.833333	12	dice	23.5	12
Affine_nomask	11.333333	13	voldiff	23.5	12
Affine_nomask	9.9375	11	landmarks	23.5	12
Similarity_masked	11.833333	12	dice	24.5	13
Similarity_masked	7	7	voldiff	24.5	13
Similarity_masked	12.125	15	landmarks	24.5	13
TRSAA_nomask	11.833333	12	dice	25	14
TRSAA_nomask	12	14	voldiff	25	14

TRSAA_nomask	10	12	landmarks	25	14
flirt_NA	13.333333	15	dice	26.5	15
flirt_NA	11.25	12	voldiff	26.5	15
flirt_na	11.125	13	landmarks	26.5	15
Similarity_nomask	15.5	16	dice	30	16
Similarity_nomask	13.5	16	voldiff	30	16
Similarity_nomask	11.375	14	landmarks	30	16
antsAI_masked	17	17	dice	34	17
antsAI_masked	14.166667	17	voldiff	34	17
antsAI_masked	14.375	17	landmarks	34	17

Supplementary Table 7: Ranking linear registration settings fetal to neonatal

algorithm	meanRanks	consensusrank	metric	summed_consesnsus_ranking	final_ranking
TRSAA_nomask	2.833	2	dice	3	1
TRSAA_nomask	3	1	landmarks	3	1

TRSAA_nomask	5.833	2	voldiff	3	1
TRSAA_masked	3.5	4	dice	7	4
TRSAA_masked	3.062	2	landmarks	7	4
TRSAA_masked	6	4	voldiff	7	4
TRSAA_eroded_masked	4.312	5	landmarks	8.5	5
TRSAA_erroded_masked	1.5	1	dice	8.5	5
TRSAA_erroded_masked	6.833	6	voldiff	8.5	5
flirt_NA	3.167	3	dice	6.5	3
flirt_na	4.062	4	landmarks	6.5	3
flirt_NA	5.833	2	voldiff	6.5	3
Affine_nomask	4	5	dice	6	2
Affine_nomask	3.688	3	landmarks	6	2
Affine_nomask	5.667	1	voldiff	6	2
Similarity_nomask	6.833	7	dice	12	6

Similarity_nomask	5.438	6	landmarks	12	6
Similarity_nomask	6.5	5	voldiff	12	6
Affine_masked	6.333	6	dice	13.5	7
Affine_masked	6.5	7	landmarks	13.5	7
Affine_masked	7	7	voldiff	13.5	7
Similarity_masked	9	9	dice	16.5	8
Similarity_masked	8.75	8	landmarks	16.5	8
Similarity_masked	7.833	8	voldiff	16.5	8
Affine_eroded_masked	9.188	9	landmarks	18	9
Affine_erroded_masked	7.833	8	dice	18	9
Affine_erroded_masked	8.167	10	voldiff	18	9
Similarity_eroded_masked	10.812	11	landmarks	20	10
Similarity_erroded_masked	10.5	10	dice	20	10
Similarity_erroded_masked	7.833	8	voldiff	20	10

terminal_CC_nomask	11.5	11	dice	21	11
terminal_CC_nomask	10.625	10	landmarks	21	11
terminal_CC_nomask	11	11	voldiff	21	11
terminal_CC_eroded_masked	11.812	13	landmarks	26.5	12
terminal_CC_erroded_masked	12.833	12	dice	26.5	12
terminal_CC_erroded_masked	12.333	15	voldiff	26.5	12
terminal_CC_masked	13.333	13	dice	26.5	12
terminal_CC_masked	11.438	12	landmarks	26.5	12
terminal_CC_masked	13.667	16	voldiff	26.5	12
terminal_MI_eroded_masked	14.625	15	landmarks	28	14
terminal_MI_erroded_masked	13.333	13	dice	28	14
terminal_MI_erroded_masked	11.167	13	voldiff	28	14
terminal_MI_nomask	14.833	15	dice	30.5	15
terminal_MI_nomask	15.375	16	landmarks	30.5	15

terminal_MI_nomask	12	14	voldiff	30.5	15
antsAI_masked	16.5	17	dice	31	17
antsAI_masked	14	14	landmarks	31	17
antsAI_masked	14.333	17	voldiff	31	17
terminal_MI_masked	15.167	16	dice	30.5	15
terminal_MI_masked	16.312	17	landmarks	30.5	15
terminal_MI_masked	11	11	voldiff	30.5	15

Supplementary Table 8: Ranking nonlinear registration settings fetal to template

Registration setting tested	meanRanks	consensusrank	metric	summed_consesnsus_ranking	final_ranking
SyNOnly_CC_2_reg_iter_1_bleached_masked	4.833	1	voldiff	4.5	1
SyNOnly_CC_2_reg_iter_1_bleached_masked	5.5	3	landmarks	4.5	1
SyNOnly_CC_2_reg_iter_1_bleached_masked	4.333	2	dice	4.5	1
SyNOnly_CC_2_reg_iter_1_normal_masked	6.333	4	voldiff	6	2

SyNOnly_CC_2_reg_iter_1_normal_masked	4.75	2	landmarks	6	2
SyNOnly_CC_2_reg_iter_1_normal_masked	5.5	4	dice	6	2
SyNOnly_CC_4_reg_iter_1_bleached_masked	5.5	3	voldiff	6	2
SyNOnly_CC_4_reg_iter_1_bleached_masked	6	4	landmarks	6	2
SyNOnly_CC_4_reg_iter_1_bleached_masked	4.333	1	dice	6	2
SyNOnly_CC_4_reg_iter_1_normal_masked	10.167	10	voldiff	9.5	4
SyNOnly_CC_4_reg_iter_1_normal_masked	4.688	1	landmarks	9.5	4
SyNOnly_CC_4_reg_iter_1_normal_masked	8.5	7	dice	9.5	4
SyNOnly_CC_6_reg_iter_1_bleached_masked	7.667	5	voldiff	10	5
SyNOnly_CC_6_reg_iter_1_bleached_masked	6.938	6	landmarks	10	5
SyNOnly_CC_6_reg_iter_1_bleached_masked	5.333	3	dice	10	5
SyNOnly_CC_2_reg_iter_0_bleached_masked	5.333	2	voldiff	11	6
SyNOnly_CC_2_reg_iter_0_bleached_masked	8.25	7	landmarks	11	6
SyNOnly_CC_2_reg_iter_0_bleached_masked	7.5	6	dice	11	6

SyNOnly_CC_6_reg_iter_1_normal_masked	11.333	12	voldiff	15	7
SyNOnly_CC_6_reg_iter_1_normal_masked	6	4	landmarks	15	7
SyNOnly_CC_6_reg_iter_1_normal_masked	9.667	10	dice	15	7
SyNOnly_MI_32_reg_iter_1_bleached_masked	9	6	voldiff	16	8
SyNOnly_MI_32_reg_iter_1_bleached_masked	10.5	11	landmarks	16	8
SyNOnly_MI_32_reg_iter_1_bleached_masked	5.5	4	dice	16	8
SyNOnly_CC_4_reg_iter_0_bleached_masked	9.167	7	voldiff	16.5	9
SyNOnly_CC_4_reg_iter_0_bleached_masked	9.875	9	landmarks	16.5	9
SyNOnly_CC_4_reg_iter_0_bleached_masked	8.833	8	dice	16.5	9
SyNOnly_CC_2_reg_iter_0_normal_masked	9.833	8	voldiff	17.5	10
SyNOnly_CC_2_reg_iter_0_normal_masked	9.312	8	landmarks	17.5	10
SyNOnly_CC_2_reg_iter_0_normal_masked	10	11	dice	17.5	10
SyNOnly_CC_6_reg_iter_0_bleached_masked	9.833	8	voldiff	22.5	11
SyNOnly_CC_6_reg_iter_0_bleached_masked	11.062	13	landmarks	22.5	11

SyNOnly_CC_6_reg_iter_0_bleached_masked	10	11	dice	22.5	11
SyNOnly_MI_32_reg_iter_1_normal_masked	11.833	13	voldiff	23	12
SyNOnly_MI_32_reg_iter_1_normal_masked	10.438	10	landmarks	23	12
SyNOnly_MI_32_reg_iter_1_normal_masked	10.333	13	dice	23	12
SyNOnly_CC_4_reg_iter_0_normal_masked	11	11	voldiff	24.5	13
SyNOnly_CC_4_reg_iter_0_normal_masked	10.625	12	landmarks	24.5	13
SyNOnly_CC_4_reg_iter_0_normal_masked	12.833	14	dice	24.5	13
SyNOnly_MI_32_reg_iter_0_bleached_masked	11.833	13	voldiff	26	14
SyNOnly_MI_32_reg_iter_0_bleached_masked	12.625	15	landmarks	26	14
SyNOnly_MI_32_reg_iter_0_bleached_masked	9.167	9	dice	26	14
SyNOnly_CC_6_reg_iter_0_normal_masked	12.167	15	voldiff	28.5	15
SyNOnly_CC_6_reg_iter_0_normal_masked	11.062	13	landmarks	28.5	15
SyNOnly_CC_6_reg_iter_0_normal_masked	14.667	16	dice	28.5	15
SyNOnly_MI_32_reg_iter_0_normal_masked	13.833	17	voldiff	32	16

SyNOnly_MI_32_reg_iter_0_normal_masked	14.062	16	landmarks	32	16
SyNOnly_MI_32_reg_iter_0_normal_masked	13.167	15	dice	32	16
TVMSQC_bleached_masked	13	16	voldiff	34.5	17
TVMSQC_bleached_masked	17.188	18	landmarks	34.5	17
TVMSQC_bleached_masked	16.667	17	dice	34.5	17
TVMSQ_bleached_masked	15.333	18	voldiff	35	18
TVMSQ_bleached_masked	16.438	17	landmarks	35	18
TVMSQ_bleached_masked	16.667	18	dice	35	18
TVMSQ_normal_masked	15.833	19	voldiff	38	19
TVMSQ_normal_masked	17.312	19	landmarks	38	19
TVMSQ_normal_masked	17.833	19	dice	38	19
TVMSQC_normal_masked	16.167	20	voldiff	40	20
TVMSQC_normal_masked	17.375	20	landmarks	40	20
TVMSQC_normal_masked	19.167	20	dice	40	20

Supplementary Table 9: Ranking nonlinear registration settings neonatal to template

Registration setting tested	meanRanks	consensusrank	metric	summed_consesnsus_ranking	final_ranking
SyNOnly_CC_2_reg_iter_1_normal_masked	1.167	1	dice	3	1
SyNOnly_CC_2_reg_iter_1_normal_masked	3.667	1	voldiff	3	1
SyNOnly_CC_2_reg_iter_1_normal_masked	2.375	2	landmarks	3	1
SyNOnly_CC_4_reg_iter_1_normal_masked	2.333	2	dice	3	1
SyNOnly_CC_4_reg_iter_1_normal_masked	4.333	2	voldiff	3	1
SyNOnly_CC_4_reg_iter_1_normal_masked	2.188	1	landmarks	3	1
SyNOnly_CC_6_reg_iter_1_normal_masked	3.5	3	dice	5.5	3
SyNOnly_CC_6_reg_iter_1_normal_masked	4.333	2	voldiff	5.5	3
SyNOnly_CC_6_reg_iter_1_normal_masked	3	3	landmarks	5.5	3
SyNOnly_MI_32_reg_iter_1_normal_masked	3.667	4	dice	8	4
SyNOnly_MI_32_reg_iter_1_normal_masked	4.833	4	voldiff	8	4
SyNOnly_MI_32_reg_iter_1_normal_masked	4.625	4	landmarks	8	4
SyNOnly_CC_2_reg_iter_0_normal_masked	4.5	5	dice	10	5

SyNOnly_CC_2_reg_iter_0_normal_masked	5.333	5	voldiff	10	5
SyNOnly_CC_2_reg_iter_0_normal_masked	4.812	5	landmarks	10	5
SyNOnly_CC_4_reg_iter_0_normal_masked	6.333	6	dice	12.5	6
SyNOnly_CC_4_reg_iter_0_normal_masked	5.5	7	voldiff	12.5	6
SyNOnly_CC_4_reg_iter_0_normal_masked	6.062	6	landmarks	12.5	6
SyNOnly_CC_6_reg_iter_0_normal_masked	7.333	8	dice	13.5	7
SyNOnly_CC_6_reg_iter_0_normal_masked	5.333	5	voldiff	13.5	7
SyNOnly_CC_6_reg_iter_0_normal_masked	6.25	7	landmarks	13.5	7
SyNOnly_MI_32_reg_iter_0_normal_masked	7.167	7	dice	15.5	8
SyNOnly_MI_32_reg_iter_0_normal_masked	6.333	8	voldiff	15.5	8
SyNOnly_MI_32_reg_iter_0_normal_masked	7.312	8	landmarks	15.5	8
TVMSQ_normal_masked	9.167	9	dice	17.5	9
TVMSQ_normal_masked	6.333	8	voldiff	17.5	9
TVMSQ_normal_masked	8.938	9	landmarks	17.5	9

TVMSQC_normal_masked	9.833	10	dice	20	10
TVMSQC_normal_masked	9	10	voldiff	20	10
TVMSQC_normal_masked	9.438	10	landmarks	20	10

Supplementary Table 10: Ranking nonlinear registration settings fetal to neonatal

algorithm	meanRanks	consensusrank	metric	summed_consesnsus_ranking	final_ranking
SyNOnly_CC_2_reg_iter_1_bleached_masked	3.5	1	landmarks	2.5	1
SyNOnly_CC_2_reg_iter_1_bleached_masked	2.333	1	dice	2.5	1
SyNOnly_CC_2_reg_iter_1_bleached_masked	6.667	2	voldiff	2.5	1
SyNOnly_CC_4_reg_iter_1_bleached_masked	5.75	3	landmarks	5	2
SyNOnly_CC_4_reg_iter_1_bleached_masked	2.333	1	dice	5	2
SyNOnly_CC_4_reg_iter_1_bleached_masked	7.167	3	voldiff	5	2
SyNOnly_CC_2_reg_iter_0_bleached_masked	6.438	4	landmarks	6.5	3
SyNOnly_CC_2_reg_iter_0_bleached_masked	4.667	4	dice	6.5	3
SyNOnly_CC_2_reg_iter_0_bleached_masked	6.5	1	voldiff	6.5	3

SyNOnly_CC_2_reg_iter_1_normal_masked	5.25	2	landmarks	10	4
SyNOnly_CC_2_reg_iter_1_normal_masked	6.833	6	dice	10	4
SyNOnly_CC_2_reg_iter_1_normal_masked	8.833	10	voldiff	10	4
SyNOnly_CC_6_reg_iter_1_bleached_masked	7.625	5	landmarks	10.5	5
SyNOnly_CC_6_reg_iter_1_bleached_masked	3.667	3	dice	10.5	5
SyNOnly_CC_6_reg_iter_1_bleached_masked	8.333	8	voldiff	10.5	5
SyNOnly_CC_4_reg_iter_0_bleached_masked	7.875	6	landmarks	11	6
SyNOnly_CC_4_reg_iter_0_bleached_masked	6.833	6	dice	11	6
SyNOnly_CC_4_reg_iter_0_bleached_masked	7.667	4	voldiff	11	6
SyNOnly_MI_32_reg_iter_1_bleached_masked	8.625	8	landmarks	12.5	7
SyNOnly_MI_32_reg_iter_1_bleached_masked	6.167	5	dice	12.5	7
SyNOnly_MI_32_reg_iter_1_bleached_masked	7.667	4	voldiff	12.5	7
SyNOnly_CC_4_reg_iter_1_normal_masked	8.125	7	landmarks	18	10
SyNOnly_CC_4_reg_iter_1_normal_masked	9.5	10	dice	18	10

SyNOnly_CC_4_reg_iter_1_normal_masked	11.5	12	voldiff	18	10
SyNOnly_CC_2_reg_iter_0_normal_masked	8.875	9	landmarks	17.5	8
SyNOnly_CC_2_reg_iter_0_normal_masked	9.167	9	dice	17.5	8
SyNOnly_CC_2_reg_iter_0_normal_masked	8.333	8	voldiff	17.5	8
SyNOnly_CC_6_reg_iter_0_bleached_masked	9.312	10	landmarks	17.5	8
SyNOnly_CC_6_reg_iter_0_bleached_masked	7.667	8	dice	17.5	8
SyNOnly_CC_6_reg_iter_0_bleached_masked	8.167	7	voldiff	17.5	8
SyNOnly_MI_32_reg_iter_0_bleached_masked	9.438	11	landmarks	19	11
SyNOnly_MI_32_reg_iter_0_bleached_masked	9.5	10	dice	19	11
SyNOnly_MI_32_reg_iter_0_bleached_masked	8	6	voldiff	19	11
SyNOnly_CC_6_reg_iter_1_normal_masked	10.25	12	landmarks	24.5	12
SyNOnly_CC_6_reg_iter_1_normal_masked	11.667	12	dice	24.5	12
SyNOnly_CC_6_reg_iter_1_normal_masked	12.5	13	voldiff	24.5	12
SyNOnly_CC_4_reg_iter_0_normal_masked	11.062	13	landmarks	25	13

SyNOnly_CC_4_reg_iter_0_normal_masked	12.667	13	dice	25	13
SyNOnly_CC_4_reg_iter_0_normal_masked	11	11	voldiff	25	13
SyNOnly_MI_32_reg_iter_1_normal_masked	12.125	14	landmarks	27.5	14
SyNOnly_MI_32_reg_iter_1_normal_masked	12.833	14	dice	27.5	14
SyNOnly_MI_32_reg_iter_1_normal_masked	12.5	13	voldiff	27.5	14
SyNOnly_CC_6_reg_iter_0_normal_masked	12.375	15	landmarks	30	15
SyNOnly_CC_6_reg_iter_0_normal_masked	14.5	15	dice	30	15
SyNOnly_CC_6_reg_iter_0_normal_masked	12.667	15	voldiff	30	15
SyNOnly_MI_32_reg_iter_0_normal_masked	14.688	16	landmarks	32	16
SyNOnly_MI_32_reg_iter_0_normal_masked	15.667	16	dice	32	16
SyNOnly_MI_32_reg_iter_0_normal_masked	13.833	16	voldiff	32	16
TVMSQ_bleached_masked	16.5	17	landmarks	34.5	17
TVMSQ_bleached_masked	17.5	17	dice	34.5	17
TVMSQ_bleached_masked	14.333	18	voldiff	34.5	17

TVMSQC_normal_masked	17.375	19	landmarks	36	18
TVMSQC_normal_masked	18.5	18	dice	36	18
TVMSQC_normal_masked	13.833	16	voldiff	36	18
TVMSQC_bleached_masked	17.25	18	landmarks	37.5	19
TVMSQC_bleached_masked	19.5	20	dice	37.5	19
TVMSQC_bleached_masked	15.167	19	voldiff	37.5	19
TVMSQ_normal_masked	17.562	20	landmarks	39	20
TVMSQ_normal_masked	18.5	18	dice	39	20
TVMSQ_normal_masked	15.333	20	voldiff	39	20

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