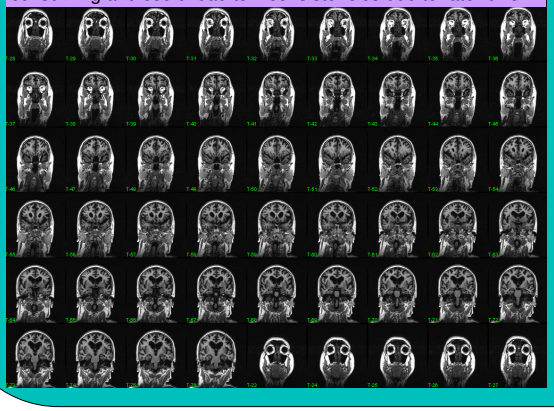
# Automated segmentation of the hippocampus in the LBC 1936 cohort

LBC 1936

## Introduction

As we age our brains suffer atrophy, to what degree different structures and sub-regions are affected is currently being investigated (Raz et al 2010). Age-related atrophy has been linked to cognitive decline (Staff et al 2006), and the hippocampus is a structure that has received a lot of attention due to its role in disorders such as Alzheimer disease and Schizophrenia (Wang et al 2003).

The usual method of obtaining hippocampal volume measurements is to manually delineate the structure in every slice where it appears. In a large cohort this is extremely time consuming and could lead to inconsistencies due to rater error.



Automated techniques are in use but have difficulty accounting for healthy age-related atrophy such as enlarged ventricles and focal pathologies (Van der Lijn et al 2008). This is often due to the use of brain templates during the registration stage of the process, which are based upon young healthy individuals.

Poorly registered image

## Summary

It is important to look at small regions (hippocampus) in healthy brains that are affected by diseases such as dementia, so that we can better understand the causes of these diseases. This requires accurate and detailed measurements of brain regions to be taken, however it is a difficult and time consuming task. To make the task quicker computer programs like FSL_FIRST can be used. We tested how well this program measured the hippocampus by visually inspecting the results of the measurements. FSL_FIRST was not very accurate at measuring the hippocampus, therefore further work is necessary to improve the program.

## Method

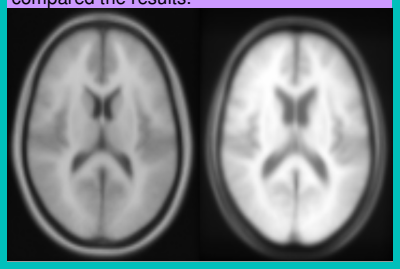
A literature search revealed very few automated techniques that have been successfully applied to a healthy older population.

Collaboration through SINAPSE with Dr Trevor Ahearn at the University of Aberdeen, revealed that the Aberdeen group had used FSL_FIRST to segment the hippocampus in the Aberdeen Birth Cohort 1936 (ABC1936).

As in the Lothian Birth Cohort (LBC1936) used in this study, the ABC1936 cohort is made up of healthy older individuals who, as well as cognitive and physical tests, underwent MRI.

We ran FSL_FIRST using a sample of 30 participants MR images from the LBC1936 cohort, representing a range of atrophy (Deary et al 2007).

We applied FSL_FIRST using the standard MNI152 template within the software, and using a template derived in-house from an ageing cohort of 65 -70 yr old men and compared the results.



MNI152 Template | 65 – 70 year old Template

**FSL_FIRST steps**

Nonlinear noise reduction

▼

Registration to whole brain template (MNI 152)

▼

Registration to subcortical mask

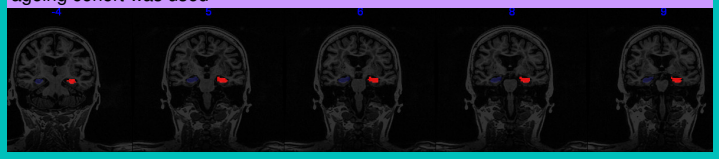
▼

Shape modelling – algorithm searches combinations of shapes finds the most probable shape to fit the image

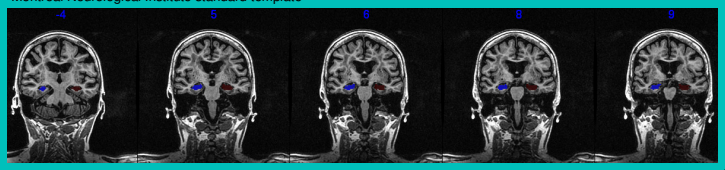
http://www.fmrib.ox.ac.uk/fsl/

## Results

14 of 64 hippocampi were delineated with a high degree of accuracy (22%), with significant errors found in 12 (19%) for both templates. The errors were localised in the posterior and anterior boundaries, where the method seemed to over-estimate the size of the hippocampus, though commonly omitted to include the uncinate process. The segmentation visually improved when the template derived from an ageing cohort was used



Montreal Neurological Institute standard template

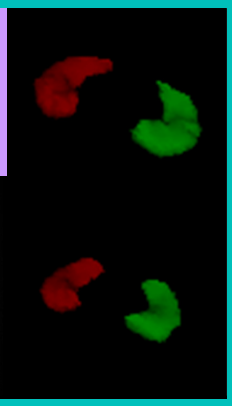


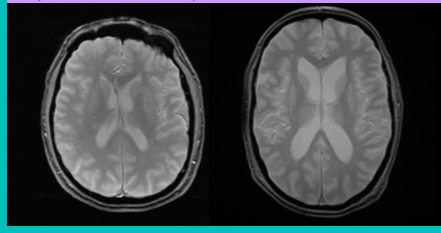
65-70 yr olds template

## Discussion

A possible explanation for poor performance of FSL_FIRST could be the wide variation in ventricle size and atrophy of the hippocampus present in healthy older participants.

Shapes accounting for these variations are not well represented in the training set, which FIRST searches through to find the best fit. This variation can also cause poor registration as the landmarks used to map the template are not in the expected location.





## Conclusions and further work

The results from FSL_FIRST will be compared to manually delineated segmentations performed on the same 30 MR images, to also provide a quantitative measure of accuracy.

We have begun investigating whether other registration techniques and the use of a template that is more representative of the LBC 1936 cohort could improve the FSL_FIRST segmentation.

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SFC Brain Imaging Research Centre
Centre for Cognitive Ageing and Cognitive Epidemiology

Lifelong Health & Wellbeing Research for Healthy Ageing | ageUK

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