The Absolute Beginner's Guide to Diffusion Tensor MR Imaging

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Diffusion tensor imaging is proving to be an extremely useful imaging modality, both in clinical applications and in the basic research arena. However, there is a burgeoning body of literature on the topic, making it difficult for the complete beginner to get to grips with the basic concepts. Furthermore, there is a whole terminology that needs to be learned and understood before a lot of the DTI papers can be understood, potentially leaving some people bewildered. For example *"What do they mean by antipodally symmetric? What is positive definite? What is the sorting bias? What exactly is fractional anisotropy and why is it used? What is a b-value? What is a b-matrix?*" This presentation will assume that the audience knows next to nothing about diffusion MRI (but perhaps a little about MRI itself) and will aim to introduce all the basic concepts.

We will begin by looking at properties of random walks and the origin of the term 'apparent diffusion coefficient'. We will then examine how the MR signal can be sensitized to diffusion, explaining the use of diffusion encoding gradients. Next, the effect of tissue microstructure on the MR signal will be discussed which will prompt the introduction of the diffusion tensor model.

After introducing the tensor model, we will explore what is meant by 'diagonalizing the tensor' and what the eigenvalues and eigenvectors represent. Next, we will focus on the basics of how to acquire data suitable for estimating the tensor and take a brief look at the mathematics of the estimation of the tensor.

Next we will look at the quantitative metrics that can be obtained from the eigenvalues of the tensor, including the trace and various anisotropy indices and examine why more primitive measures are not used. A few example applications will be given.

We will then turn our attention to the orientational information contained in the eigenvectors and explore colour mapping of fibre orientation before moving onto fibre tracking or tractography. First, we will explore deterministic tracking before motivating the use of probabilistic tracking.

Finally, we will explore sources of artefact in diffusion tensor imaging and see how they may confound measurements and discuss possible ways to ameliorate these problems.

At the end of the talk, it is hoped that the complete beginner to DT-MRI will be able to converse fluently with other DT-MRI enthusiasts, or at least nod nonchalantly at the appropriate points.