

**Derek K Jones**  
**[Representing the Diffusion / Perfusion Study Group]**

**Mailing Address:**  
**Centre for Neuroimaging Sciences**  
**Institute of Psychiatry, P089**  
**De Crespigny Park**  
**London, SE21 8LU. United Kingdom.**

**Tel: +44-207-919-3057**  
**Email: [d.jones@iop.kcl.ac.uk](mailto:d.jones@iop.kcl.ac.uk)**

**Message from author:**

I realise that the format of this abstract might not conform exactly to the guidelines outlined on the website - but:

(a) I think the exercise we did was a valuable one - and it would be good to record the results - as a valuable resource for the MR community

(b) I have to catch a train shortly - and do not have time to work a lot on this - but it occurred to me today that it would be a real shame if the work went to waste.

So - please find attached an abstract that collates the results of the poll that I did. I consider this an abstract belonging to the study group, rather than an individual - and, if it were accepted, I would co-erce (!) members of the group to present aspects - highlighting sections of the list.

# Unresolved issues in Diffusion and Perfusion MRI

## A Consensus from the Study Group

### The ISMRM Diffusion Perfusion Study Group

#### **Abstract**

In response to the new initiative, members of the Diffusion Perfusion study group were asked to suggest outstanding issues in the field. Approximately 40 outstanding issues were collected, and members were then asked to identify (in order of importance) the top 5 issues. The results of the vote yielded the 'Top Twenty' – which is given below. This serves as a valuable resource to direct research in the future. The background to the top issues will be presented by members of the study group, together with some descriptions of pertinent work.

#### **Results:**

*If only we could:*

1. "Definitively quantify the contributions of the intra- and extra-cellular components to the diffusion signal"
2. "Measure brain perfusion in acute stroke patients accurately enough to be useful"
3. "Have realistic phantoms for diffusion imaging"
4. "Quantify connectivity between different regions, separated by different distances, reliably and consistently"
5. "Have an accepted and practical gold standard for tract tracing in the human brain"
6. "Reliably measure the vascular territories of individual arteries"
7. "Better understand the biophysical nature of diffusion MR signal, in order to optimize diffusion experiments more effectively"
8. "Have a definitive, reproducible and easy way of calibrating ASL experiments with respect to M0 (of tissue or blood, depending on the model) in order to get quantitative CBF values"
9. "Use diffusion-derived measures, other than the mean diffusivity, in a clinical manner"
10. "Have standard post-processing software (including motion correction) for ASL integrated onto a clinical scanner"
11. "Perform meaningful group comparisons on low dimensionality diffusion data (scalar invariants of the tensor), even if we don't understand the biophysical mechanisms underlying them" / "Perform meaningful voxel-based comparisons of DTI data"
12. "Reliably quantify the dependence of diffusion on diffusion time, to identify different tissue types or geometrical features"
13. "Have realistic phantoms for perfusion imaging"
14. "Use DTI to reliably discriminate tumor infiltration from bland (tumor-free) edema"
15. "Use arterial spin labeling to measure perfusion in white matter"
16. "Establish the definitive biophysical mechanism underlying the dependence of ADC on the b-value in the brain".
17. "Resolve the topological ambiguity in diffusion displacement profiles (cross, kiss, twist, bend)"
18. "Reach a common consensus, once and for all, on the number of directions needed for DTI, and the b-values needed (i.e., do we need  $b < 600$  s/mm<sup>2</sup> or  $b > 3000$  s/mm<sup>2</sup>)"
19. "Identify the cellular correlates of changes in diffusion anisotropy in white matter"
20. "Know whether FA abnormalities in specific fibers correlate with fMRI abnormalities in gray matter (i.e., use DTI to predict the outcome of fMRI experiments)" / "Identify the functional basis and the functional meaning of DTI"

