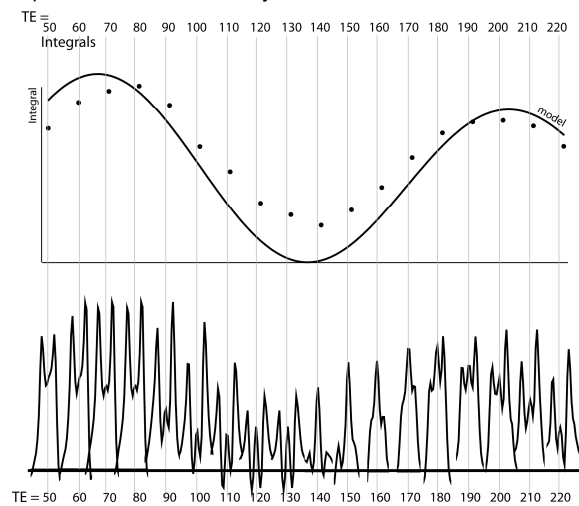


# In Vivo T2 of GABA at 7T: measuring transverse relaxation times using edited MRS

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Accurate measurement of in vivo relaxation times is a foundation stone of quantitative *in vivo* magnetic resonance spectroscopy. Transverse relaxation times for NAA, Creatine and Choline<sup>1</sup> are generally measured by fitting exponential decay curves to single-voxel spectra acquired at multiple echo times (TE). However in the case of coupled metabolites, TE-dependence in signal amplitudes arises from coupling evolution and T2 relaxation, making calculation of T2 relaxation times less easy. T2 measurements of coupled metabolites have been made using localised spectroscopy<sup>2</sup>, but edited experiments are necessary to measure a number of metabolites, such as GABA. In this abstract we show that edited phantom measurements can characterize the TE dependence of signal amplitudes, allowing in vivo T<sub>2</sub>s to be measured using edited *in vivo* acquisitions. This process is demonstrated for GABA, but generalizes to other edited metabolites, such as glutathione and NAAG.



posterior cingulate cortex.

## Modelling Theory

MEGA-PRESS is a difference method that acquire two experiments: one with frequency-selective editing pulses applied to GABA spins at 1.9 ppm; and one with no editing pulses applied. The Difference between these two experiments is the edited spectrum, which contains signals that are altered by the editing pulses, and the 'SUM' contains all the other signals in the conventional MR spectrum.

Assuming that the GABA signal at 3 ppm is a triplet with coupling constant J, the signal intensity in the edited DIFF spectra for a range of TEs would be expected to be:

$$S(TE) = S_0 \exp(-TE/T_{2,phantom}) \sin \pi J TE. \quad [1]$$

Fitting this equation to the data in Figure 1A allow the T<sub>2,phantom</sub> to be calculated.

Given the form of this curve, in vivo measurements made around TE=70 and TE = 210 ms are expected to have good SNR and sufficiently spaced TEs to allow a measurement of T<sub>2,add</sub> in this equation.

$$S(TE) = S_0 \exp(-TE/T_{2,phantom}) \sin \pi J TE \exp(-TE/T_{2,add}). \quad [2]$$

T<sub>2,in vivo</sub> can then be calculated from:

$$1/T_{2,in vivo} = 1/T_{2,phantom} + 1/T_{2,add} \quad [3]$$

## Results

Good quality edited spectra have been acquired in vivo at a range of echo times. Figure 1 shows the edited GABA spectrum from 2.92-3.10 ppm. From the integrals and Eq. 1, T<sub>2,phantom</sub> is estimated to be ~700 ms. Edited spectra are also acquired in vivo (see Figure 2A). Fitting to Equation 2 gives a T<sub>2,add</sub> of 57 ms (additional curves for 51 ms and 63 ms are shown), giving a total *in vivo* T2 of GABA of 53 ms at 7T.

## Discussion

The *in vivo* T2 of GABA has been measured for the first time; this is a very important step in establishing quantitative measurements of GABA concentration. GABA, the main inhibitory neurotransmitter, is being widely studied by edited MRS, but it is usual currently to quote GABA concentrations in institutional units, which may vary from lab to lab. Measurements of GABA relaxation parameters are needed before this literature can be brought into line with standard quantification methods used for NAA, creatine and choline.

Further modelling work is needed to accurately characterize the TE curve shown in Figure 1. This preliminary data relies upon a single long-TE measurement at 200 ms, and further measurements are needed to establish the reproducibility of this measurement.

**References** 1. Tkac, MRM 6:451 2001. 2. Xin et al. NMR Biomed 21:396 2008. 3. Choi et al. MRM 56:971 2006.

