MR Analysis of Structural Contrast in Rodent Models of ADHD as a Function of Magnetic Field

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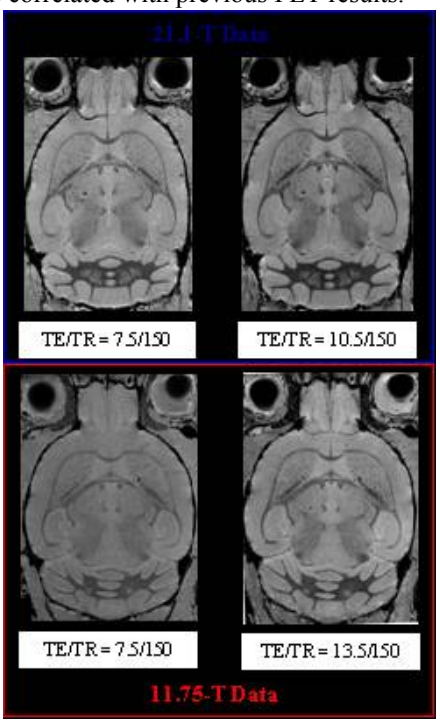
Introduction

This analysis utilizes Magnetic Resonance Imaging (MRI) to assess morphological changes in brain structures that may result from Attention Deficit Hyperactivity Disorder (ADHD) pathology and treatment. The rodent models being used to analyze ADHD are either genetic models that evaluate specific neurotransmitter receptors (such as a mutation in the dopamine-2 receptors) or exogenous models that have been exposed to certain toxins that exhibit effects similar to ADHD. These mouse and rat models have been developed to evaluate the effects of Ritalin and Amphetamine on brain function and structure. It is known that the forebrain and the striatum in particular are the target areas for psychostimulants, such as Ritalin, cocaine and amphetamines [1]. In previous ADHD work, researchers observed that, after oral administration of Ritalin, a higher uptake was observed in the striatum than in the cerebellum [2]. The objective of the current study is to utilize the high resolution, non-destructive techniques of MRI to evaluate changes in neuroanatomy that can be correlated with previous PET results.

Experimental

To aid in this effort, the development of MRI protocols necessary to segment regions of interest in the rodent (mouse and/or rat) brain as a function of field strength have been developed. Excised rodent brains were analyzed at magnetic field strengths of 11.75 and 21.1 T available at The National High Magnetic Field Laboratory and The Florida State University. A three-dimensional (3D) gradient-recalled echo (GRE) sequence was used to acquire datasets at an isotropic resolution of 50 μm. An initial objective of this study was to define parameters that optimize regional contrast of neuroanatomical structures as a function of magnetic field strength. Additionally, emphasis was placed on identifying additional neuronal features that might be more clearly delineated at 21.1 T. To this end, contrast mechanisms in these fixed samples were evaluated for the purpose of optimizing image quality and contrast for segmentation. T2*- and T1-weighted GRE images were acquired over a range of TE and TR values at both fields. Structures expected to be relevant to the ADHD pathology were segmented using a 3D rendering software (AMIRA).



Results and Discussion

Sample 2D partitions from true 3D GRE datasets are presented for different TE times at the different fields. Contrast analysis and segmentation of these datasets is continuing but these initial results indicate the differences in contrast apparent between these field strengths. Ultimately, identifying the parameters that give the highest SNR and CNR values for neuroanatomical segmentation will permit us to optimize the protocols necessary for semi-automated analysis of the rodent brain at both 11.75 and 21.1 T.

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References

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[2] Ding, Yu-Shin, et al. Synapse 53:168-175 (2004).