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Editorial

The Potential of Applied Brain Imaging in Research and Clinical Settings

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1. Introduction

Applied neuroimaging is a constantly developing field of radiology with both clinical and research applications. There has recently been a plethora of high-impact neuroscience papers that capitalize on advanced neuroimaging techniques. These include, but are not limited to, the structural magnetic resonance techniques (MRI) of voxel-based morphometry (VBM), cortical thickness, diffusion tensor imaging (DTI) and tractography, and functional MRI (fMRI) to test hypotheses.

A range of software improvements have enabled the evaluation of physiological and pathological processes, and have now been implemented across a spectrum of neurological and psychiatric conditions [1–3]. Despite the differences between specific imaging techniques, the shared goal of applied imaging studies is to detect, characterize and critically interpret subtle pathological changes *in vivo* that complement clinical observations. These can support the prevailing views on disease mechanisms and often track the changes longitudinally. The introduction of advanced structural (gray matter (GM), white matter (WM)) and especially functional neuroimaging techniques has further enabled the study of regenerative processes. The latter is of great importance since adaptive processes underpin multidisciplinary rehabilitation approaches. Although neural plasticity and neurorehabilitation have been widely studied in several neurological and psychiatric conditions [4], adaptive mechanisms in neurodegenerative conditions such as motor neuron disorder (MND) are seldom evaluated [5]. Seminal papers have described pre-symptomatic changes in mutation carriers, revealed propagation patterns in neurodegenerative conditions, and confirmed treatment effects in clinical trials, thereby contributing many novel insights [6].

The methodological focus of the nine papers included in this Research Topic differ according to the specialized expertise of the authors. Nevertheless, a cohesive theme amongst the papers highlights the potential for different applied brain imaging modalities to identify brain alterations in clinical and research settings.

With regard to asymptomatic adults with occult brain findings, Ghazali *et al.* [7] draw the reader's attention to occult cerebral small vessel disease (CSVD) which can be detected by MRI as enlarged perivascular spaces (ePVS) and WM hyperintensities (WMHs). These authors report that higher ePVS load and reduced hippocampal volume in ePVS subjects is associated with impaired processing speed and impaired working memory, respectively. Moving to symptomatic cases with cerebrovascular pathology, Vaclavik *et al.* [8] give an elegant overview of computed tomography (CT) perfusion in anterior circulation stroke and discuss key technical aspects of CT perfusion, its clinical significance, and its role in the diagnosis of stroke mimics. Kwon and Jang [9] focus on unilateral intracerebral hemorrhage (ICH) and examine WM changes in the unaffected hemisphere using DTI and tract-based spatial statistics (TBSS). Their study highlights the need to evaluate both the affected and unaffected hemisphere following unilateral ICH. This allows suitable therapeutic strategies to be developed, including precise neuro-rehabilitation and the prediction of outcome.

With regard to mild head injury, Kim *et al.* [10] report the case of an 82-year-old patient with delayed-onset bilateral subdural hematoma (SDH) five weeks after a mild head injury. The authors emphasize the need for frequent follow-up of elderly patients suffering mild head injuries, even if the initial CT findings and short-term follow-up MR imaging are normal.

Advanced neuroimaging techniques have contributed to the identification of motor and extra-motor brain pathology in MND patients that correlates with their motor and extra-motor symptoms. Chipika *et al.* [11] evaluated changes in cortical, subcortical and WM structures that are involved in the processing, relaying and mediation of sensory information in patients with amyotrophic lateral sclerosis (ALS). This is a novel study since changes in sensory networks are rarely examined in ALS, and no dedi-

cated neuroimaging study has systematically investigated the GM and WM components of sensory networks. Christidi *et al*. [12] reviewed the available magnetic resonance spectroscopy (MRS) studies on CNS metabolite concentrations in the motor regions of MND patients, as well as the few studies in extra-motor regions. These authors suggest that MRS can advance our understanding of MND biology and neurodegenerative processes. In addition, MRS has multiple practical benefits for the tracking of longitudinal changes and as a putative monitoring marker in clinical trials.

Two studies in this special issue highlight the potential of applied brain imaging for characterizing the pattern of compensatory processes in neurological disorders. Li Hi Shing *et al*. [13] present an elegant, multimodal neuroimaging study on cerebellar GM and WM in poliomyelitis survivors. The authors report considerable cerebellar reorganization decades after the poliomyelitis infection, which may be interpreted as compensation for anterior horn insult in infancy. Moreover, to unveil the contribution of cerebellum to the cognitive deficits of patients with multiple sclerosis (MS), Iliadou *et al*. [14] investigated the patterns of cerebellar GM and WM alterations and their association with cognitive performance and disability status. An interesting finding of their study was the inverse correlation observed between cerebellar volumes and cortical thickness, and scores in the cognitive tests. These associations may underlie the compensatory mechanisms.

Finally, brain imaging is emerging as a valuable tool for the *in vivo* study of brain pathology in several psychiatric conditions. Machremi *et al*. [15] contribute an authoritative review of the key neuroimaging findings in body dysmorphic disorder (BDD). They highlight the significance of neuroimaging changes in individuals with BDD and their potential role as prognostic biomarkers for treatment efficacy and disease outcome.

2. Conclusions

The nine articles in this Special Issue showcase the global potential of applied neuroimaging techniques in brain research and highlight the valuable contributions of brain imaging in both research and clinical settings. We are particularly grateful to the esteemed research groups who provided their perspective and methodological expertise, and who shared their ideas on future research directions. The implementation of different research strategies (e.g., CT perfusion, MRI volumetry, DTI tractography, fMRI, MRS), rigorous methodological approaches, and state-of-the-art techniques is certainly encouraging for the development of precision biomarkers and thus personalized care for the benefit of patients and their families.

Author Contributions

FC and EK contributed to drafting the manuscript and critically revising it for important intellectual content. The final version of the manuscript was approved by all authors.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

The authors declare no conflict of interest. Foteini Christidi and Efstratios Karavasilis were serving as Guest editors of this journal. We declare that Foteini Christidi and Efstratios Karavasilis had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to Gernot Riedel.

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