EDITORIAL

Perspectives in Applied Neuroscience Research – Part I

Applied neuroscience includes contributions and insights from neuro-biochemistry, molecular neurobiology, neuroimmunology, neuropharmacology and among others.

The present topic embraces a complex multi-dimensional interface between basic neuroscience innovative study designs, novel molecular and bio-chemical markers and drug targets; advanced computational technologies and their implementation in clinical neuropsychiatry. It will address as well the interplay of complex neurobiological factors and psychosomatic disorders.

Keywords: Neurobiology, Neuropharmacology, Neuro-imaging, Translation.

The main highlights in this special issue are:

- Therapeutic and diagnostic applications of evidence from basic neuroscience.
- Implementation and methodological issues of translation from neuroscience animal models to humans in new drug design clinico-biological trials.
- Immuno-biochemical and cellular mechanisms as drug targets for mental disorders.
- Molecular-biological mechanisms of neuropsychiatric disorders as diagnostic biomarkers.
- Novel approaches to translating and integrating the data from third-generation neuroimaging techniques and neurochemistry.

Neuroscience has evolved historically to grow from a brain research project to much broader field of multi-disciplinary explanation of the mind-brain relationships [1].

The early, proto-scientific neuroscience research has been focused exclusively on brain in sensu stricto. This includes major contributions from neuromorphology (Camillo Golgi, Santiago Ramon-y-Cajal) and neurophysiology (Emile Du Bois-Reymond) but remains restricted to accumulation of descriptive empirical knowledge on brain structure and function. In some previous publications this approach is referred to as “brain-brain” research program [2].

This view however, was revisited by the first advances in experimental neurosurgery and more specifically by Karl Wernicke and his successors. In this tradition the most important perspective before neuroscience is its involvement in the explanation of mind-brain problem or the causal determination of human behavior by neuronal mechanisms and processes [1]. Neuroscience has been considered rapidly advancing field of research since 1979. In his agenda, as published in Scientific American, Francis Crick proclaimed the frontiers of neuroscience to be expanded “from molecules to complex forms of behavior”. It might also be defined as “mind-brain” program [3].

However both programs are facing several conceptual limitations [4]. Those caveats create the so called “explanatory gap” and undermine the efforts to integrate fundamental neuroscience research into clinical applications. Those limitations include:

- **Extrapolation**: Most of the basic studies in neurobiology are performed in vitro and in animal models. The results of course are valid in the given experimental settings but it is difficult if not impossible to extrapolate then to humans because of various factors. One critical argument for instance is that the human brain is organized in far more sophisticated way from evolutionary perspective when compared to animal species to allow the emergence of consciousness. Therefore any “automatic” application of results in neuroscience models to human brain and behavior in health and disease is highly controversial from methodological point of view. On the other hand post-modern in silico, or machine learning models are proposed to have clinical utility.

- **Penetration**: Most studies, performed with humans by clinical neuroscience (e.g. neurology, psychiatry, and neurosurgery) do not penetrate to the molecular, neuro-chemical substrate of disorders. They typically use indirect methods and markers of assessment. This particular problem has been addressed by Hugdahl and Sommer in their Levels of explanation perspective [5]. Taking as an example verbal hallucinations, the authors conceptualize different (spanning from molecular to cultural) levels in vertical order and emphasize it that accumulation of knowledge in neuroscience is mainly on horizontal levels with little or no interactions across levels.

- **Objectivity**: Essentially in medicine objectivity is determined by universal, quantitative measures, which may identify and underpin different disorder mechanisms and develop treatment/drug target strategies. In neuroscience however such quantitative and bio-chemical measures do not reveal the specific processes in the brain but their peripheral correlates, given that access to direct investigation of the human brain in vivo is constricted by blood-brain and cranium barriers.
The main challenge applied to neuroscience remains the ability to translate knowledge acquired in statistical samples (big data) to individual cases [6, 7].

The rest of medical knowledge has implemented by default strategies to converge information from chemical and molecular to other vertical levels of explanation and transform it into clinical decision-making guidelines. This unfortunately is not the case with neuroscience, especially when it comes to neuropsychiatric (mental) disorders. It is assumed that most of them have underlying neuro-chemical disturbances as causal mechanisms, yet those mechanisms have not been identified to a level of consensus across disciplines and are not incorporated in clinical practice so far.

The current collection of papers is intended to address this exact issue, namely to review the state-of-the-art of the basic neuroscience research (including neuro-chemistry, neuro-pharmacology, neuro-imaging technologies) and their interplay with neuropsychiatric diagnosis and treatment.

REFERENCES


