Think Neuro

Neural Circuits and Systems Diverging Circuits

Nonhuman Modeling and its Implications in Diverging Circuit Literature

Joseph Jae Yoon Song, Aria Panjabi, Sophia Nguyen, Derek Manahan, Aleeza Khan, Sanvi Gupta, Aylin Torres, Hanna Shaiju, Sydney Ha, Iselin Wang, Darren Fang, Sophia Manole, Ak Prathipati, Emma Manole, Bryan Armbruster

Introduction

The ethical implications of utilizing human neural circuits and systems diverging circuits are extremely prevalent and propose the need for a solution which is more ethically feasible. Research considering the plasticity and adaptability of the brain is becoming more extensive and through the research presented of non-human vs. human modeling, insight is brought surrounding the accessibility, ethical implications, and cost-effectiveness of non-human neural circuits. Through the use of variable A, variable B, in-vivo, and in-vitro experimentation, the cost-effective nature, understanding the basic mechanisms that control somatosensory-guided hand and forelimb control, and the correlation of these variables are brought to light.

Objectives

- Analyze general trends of diverging circuit literature and specific influences of nonhuman models
- Discuss the implications of diverging neural circuits in human applications

Methods

- Extracted top 100 articles from Web of Science from a total of 137 articles.
- Keywords: "diverging circuits"
- Sorted information in Excel based on author, affiliation, keywords, etc.
- Inputed into R programing and complex analysis through Bibliometrix
- Data extracted and graphed through Biblioshiny

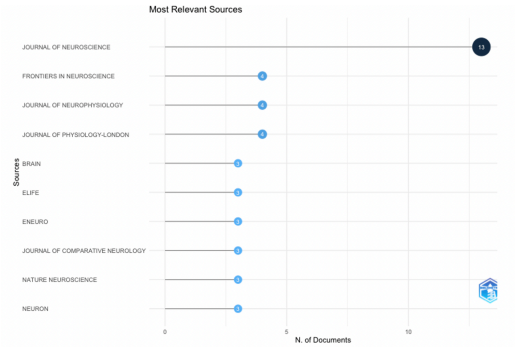

Figure 1: Most relevant and featured journals. Sources with the most articles include the Journal of Neuroscience, Frontiers in Neuroscience, Journal of Neurophysiology, Journal Physiology-London.

Results

The biblioshiny analysis revealed a gradual increase in the scientific production in the diverging neural circuit literature. Despite this publication trend, no trend in citation averages has been observed, with sharp spikes in both 2006 and 2019. The articles mainly came from neuroscience journals (Figure 1). The vast majority of models in the top 100 articles are nonhuman (73.0%), whereas the most common topics studied are that of circuit organization and the somatosensory system (Figure 2 and 3). Chi-square tests identify no strong correlation between the use of nonhuman models and the type of system studied, yielding a p-value of 0.3009. In vivo experimental methods were found to be prominent among human model studies, but a chi-square test once again identifies no strong correlation at 0.8828.

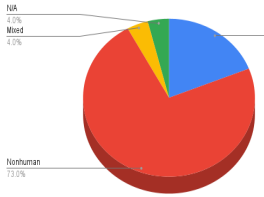

Figure 2 (Variable A): Distribution of human and nonhuman models in the 100 selected articles. Models consist of human models (19.0%), nonhuman models (73.0%), mixed models (4.0%), and no model (4.0%).

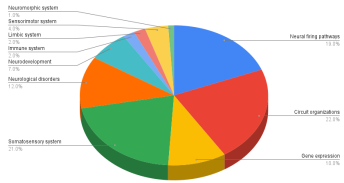

Figure 3 (Variable B): Distribution of systems and topics studied in the 100 selected articles. Common systems include circuit organization (22.0%), somatosensory system (21.0%), and neural firing pathways (19.0%).

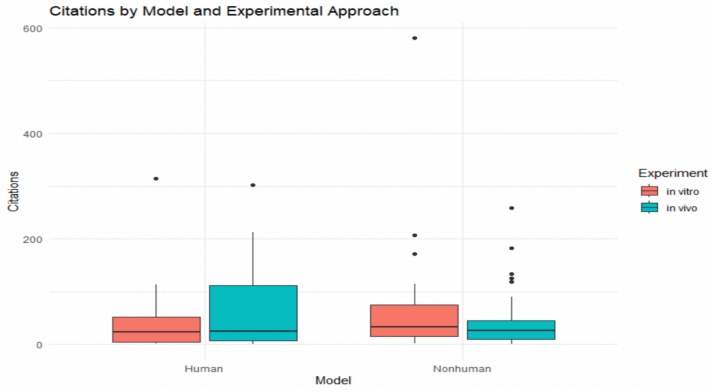

Figure 4 (Variable C): Citations by both human and nonhuman models as well as the experimental method used in each study. Most notably, human models and in vivo methods seem to hold the most influence or weight among all diverging circuit articles overall, measured by number of citations.

Discussion

The trend in scientific publications along with the relatively few article results in Web of Science implicate the recency of diverging circuit literature. The nonhuman model majority is unsurprising when accounting for their overall lower cost, allowing neuroscientists to more probe into neural structures. What is surprising is both the absence of a statistically significant correlation between nonhuman models and the type of system studied and the prevalence of in vivo experimental methods for human models. The former gives insight into the all-purpose use of nonhuman models as cost-effective replacements for studies of human function, even with direct human applications. The latter implies that the practicality of human in vitro experimental methods, such as stem cell cultures, may be nuanced than as it appears at first glance.

Conclusion

The relatively recent advent of diverging neural circuit literature is simultaneously reassuring and limiting. Its infancy means that the literature will grow substantially in the future, allowing for a more robust collection of studies that addresses the concerns raised in this study. However, the small selection of articles limit the effectiveness of the statistical analysis to identify those aforementioned trends. At the scope of current neuroscience research, which studies simpler neural systems in hopes of forming preliminary models for more complex ones, the prevalent use of nonhuman models will not be as impactful. However, they could harm the diverging circuit literature's future growth as the need to study the more complex systems themselves inevitably arrives.

References

1. Web of Science Database
2. R-Studio
3. Bibliometrix/Biblioshiny

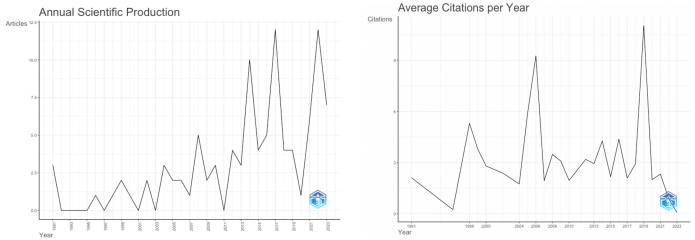

Figure 5: Annual scientific production has gradual increase, likely due to current relevance in neuroscience related studies. No specific trend in average citations per year with spikes in 2006 and 2019.