SWBioDTP 2025 Taught Course - Data Science and Machine Learning 2024 - Individual Assessment

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Introduction

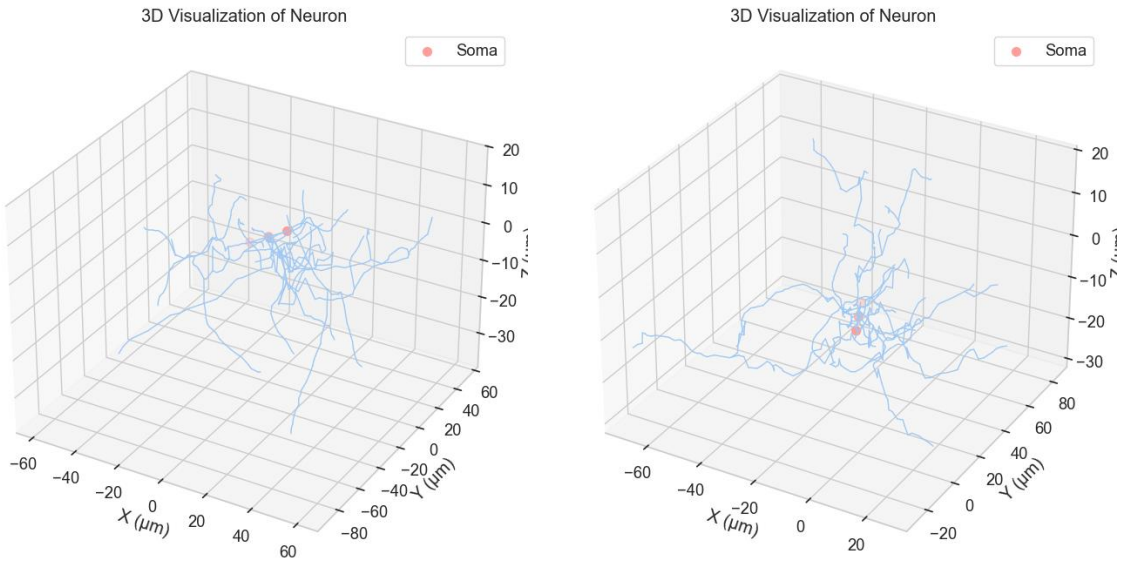
GABAergic neurons play a critical role in inhibitory signaling within the brain, contributing to the balance of excitation and inhibition necessary for proper neurological function. The neocortex and hippocampus, two regions vital for cognition and memory, exhibit unique structural and functional characteristics. This study utilizes data from NeuroMorpho.org to compare the morphologies of GABAergic neurons in the neocortex and hippocampus.

Methods

Morphological data of GABAergic neurons in healthy C57BL/6 mice in both the neocortex and hippocampus were obtained from NeuroMorpho.org . The dataset was preprocessed to filter neurons based on completeness and anatomical region. Key morphological metrics, such as total neuronal length, count in structures, soma size, and branch complexity, were extracted. Statistical analyses, including t-tests and ANOVA, were conducted to identify significant differences between the two brain regions. Data visualization techniques, such as histograms and scatter plots, were employed to illustrate findings.

Results

Analysis revealed notable differences in morphological characteristics between GABAergic neurons in the neocortex and hippocampus (Figure 1).



Neocortex *Hippocampus*

Figure 1: *Comparative visualization of GABAergic neurons.*

An independent t-test was conducted to compare the total neuronal length between the neocortex and hippocampus. The results revealed a significant difference in total neuronal length between the two regions, $t(137) = 14.254$, $p < 0.001$ (Figure 2). These findings indicate that the neuronal lengths in the neocortex and hippocampus differ significantly, suggesting structural adaptations corresponding to their distinct functional roles.

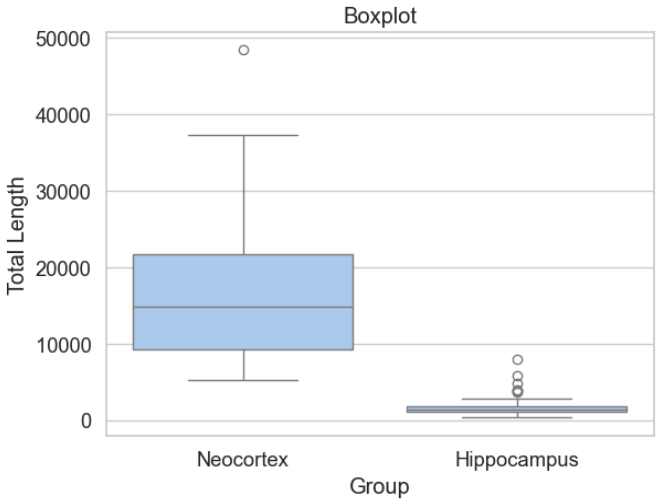


Figure 2: *Boxplot comparing total neuronal lengths in the neocortex and hippocampus*

One-way ANOVA showed that lengths of GABAergic neurons in the hippocampus exhibited greater axonal and dendritic lengths compared to those in the neocortex, with $p < 0.001$ for both analysis (Figure 3).

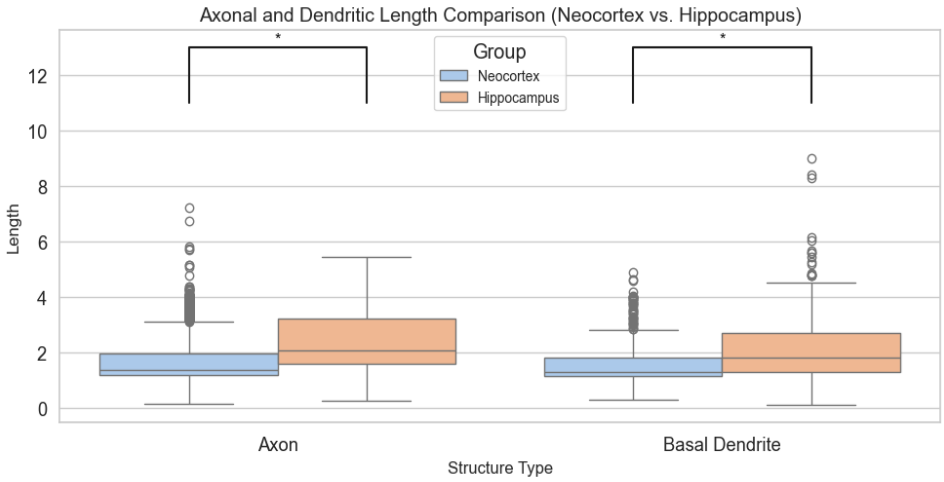


Figure 3: *Boxplot comparing individual lengths of Axons and Basal Dendrites in the neocortex and hippocampus*

Soma sizes were generally larger in the neocortex, suggesting potential differences in synaptic integration capabilities. A one-way ANOVA comparing the axonal and dendritic lengths of GABAergic neurons in the neocortex and hippocampus revealed significant differences ($p < 0.001$). The mean axonal and dendritic lengths were 16.94 and 7.03, respectively, $t(610) = 9.334$ and $p < 0.001$.

Branching patterns also varied significantly, highlighting regional adaptations to functional requirements, $t(159) = 8.213$ and $p < 0.001$. It demonstrated the comparative dendritic complexity of neurons across regions.

Conclusions

This comparative analysis highlights the morphological differences of GABAergic neurons in the neocortex and hippocampus.

Supplementary Information

GitHub link to files: https://github.com/ShittyYolanda/Data-Science—Bristol.git

1 G. A. Ascoli, D. E. Donohue, and M. Halavi, "NeuroMorpho.Org: A Central Resource for Neuronal Morphologies," The Journal of Neuroscience, vol. 27, no. 35, pp. 9247–9251, 2007.