NEUROANATOMY OF THE GREY SEAL BRAIN: BRINGING PINNIPEDS INTO THE NEUROBIOLOGICAL STUDY OF VOCAL LEARNING

NIENKE HOEKSEMA[*1,2], STELLA VILLANUEVA[3], JANINE MENGEDE[2], ANNA SALAZAR CASALS[3], ANA RUBIO GARCIA[3], BRANISLAVA CURCIC-BLAKE[4], SONJA VERNES[2,5], and ANDREA RAVIGNANI[3,6,7]

*Corresponding Author: nienke.hoeksema@mpi.nl

[1]Neurobiology of Language Department, Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands

[2]Neurogenetics of Vocal Communication Group, Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands

[3]Research Department, Sealcentre Pieterburen, Pieterburen, The Netherlands

[4]Department of Neuroscience, University Medical Center Groningen, Groningen, The Netherlands

[5]Donders Institute for Brain, Cognition & Behaviour, Nijmegen, The Netherlands

[6]Comparative Bioacoustics Group, Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands

[7]Artificial Intelligence Lab, Vrije Universiteit Brussel, Brussels, Belgium

1. Background

Vocal learning, the ability to learn novel vocalizations, is an essential part of humans' capacity for spoken language (Janik & Slater, 2000). A select group of animals – including species of bats, birds, elephants, cetaceans, and pinnipeds – also has this capability. By studying a wide range of vocal learning and non-vocal learning animals, we can increase our understanding of the neurobiological basis and evolutionary trajectory of vocal learning and human spoken language. Thus far, comparative studies have mainly centered around songbirds and non-human primates, leaving mammalian vocal learning to be understudied. Within the clade Pinnipedia, strong evidence for vocal learning has been found in both harbor seals (*Phoca vitulina*; Ralls, Fiorelli, & Gish, 1985) and grey seals (*Halichoerus grypus*; Stansbury & Janik, 2019), making them interesting targets for comparative neurobiological investigations into mammalian vocal learning. The neuroanatomy of the grey seal brain, however, has not been formally investigated.

2. Aim

The objective of the study was to conduct a first neuroanatomical investigation of the brains of grey seals to aid future comparative studies investigating the neurobiological basis of vocal learning in grey seals.

3. Methodology and Results

The brains of two female, juvenile grey seals were formalin-fixed and scanned in a 3T MRI scanner. T1- and T2-weighted image contrasts were acquired, after which the brains were dissected and photographed. A neuroanatomical atlas was created based on T2 FLAIR MR images and photographs of dissected brain slices. Moreover, a (labeled) brain template was created, as well as 3D volumetric brain models. We found that grey seal brains are larger than those of many terrestrial carnivores, and have a large cerebellum and temporal lobe, but a small olfactory area. Grey seal brains are highly convoluted, with a gyration pattern that closely matches the harbor seal brain. Building upon this work, future investigations can use diffusion tensor imaging to shed light on the neural circuits underlying vocal learning in grey seals. We are currently also exploring the expression of genes associated with vocal learning – such as FoxP2 – in collected tissue from grey seal brains via immunohistochemistry. This ongoing research will allow us to better understand the neurogenetic basis of vocal learning in grey seals.

4. Conclusion

Our study shows that the vocal learning capacity of grey seals can and should be investigated on a neurobiological level to better understand the evolution and neurobiological basis of vocal learning and human spoken language.

References

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