Hae Sol Moon, Ph.D.
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Education

Duke University, Durham, NC, USA
Ph.D. in Biomedical Engineering — August 2020 –Sept 2025

Washington University in St. Louis, St. Louis, MO, USA
M.S. in Biomedical Engineering — August 2018 – May 2020
B.S. in Applied Science, Electrical Engineering — August 2016 – December 2019
B.S. in Biomedical Engineering — August 2012 – December 2019

Research

Doctoral Research, Duke University, USA — August 2020 – July 2025
Advisor: Alexandra Badea, Ph.D.

- Investigated how Alzheimer's disease risk factors including age, sex, APOE genotype (ε2/ε3/ε4), diet, and NOS2-based immunity influence cognition, transcriptomic profiles, imaging biomarkers and brain-network connectivity in mice.
- Performed various individual and collaborative imaging and behavioral experiments.
- Designed integrative statistical and deep learning pipelines that link brain structural connectivity changes to aging, behavioral outcomes, and transcriptomics, including blood-to-brain coupling analyses.
- Developed deep learning methods for *in vivo* mouse brain masking and multimodal stroke lesion segmentation on clinical MRI, improving patient outcome prediction.

Master's Research, Washington University in St. Louis, USA — August 2018 – May 2020
Advisor: Abhinav Jha, Ph.D.

- Designed and implemented a novel DaTscan SPECT simulation and reconstruction algorithm.
- Developed a 3D deep learning segmentation pipeline for SPECT (caudate/putamen/globus pallidus) and implemented partial-volume-effect compensation using the generated segmentations.

Awards and Recognitions

- ***Robert F. Wagner All-Conference Best Student Paper Award (2nd Place)***, *SPIE Medical Imaging*, San Diego, USA, 2024
- ***Travel Award***, *International Society for Magnetic Resonance in Medicine (ISMRM)*, Toronto, Canada, 2023
- ***Young Investigator Award Finalist (Highest Scored Abstract in Data Sciences Category)***, *Society of Nuclear Medicine and Molecular Imaging (SNMMI)*, 2020
- ***Travel Award***, *World Molecular Imaging Congress (WMIC)*, Montreal, Canada, 2019

Technical Skills

Laboratory:

- Human Alzheimer's cognitive testing (administration of memory, language, odor-identification and other neuropsychological assessments)
- Mouse behavioral experiments (Morris Water Maze, Novel Odor Recognition, Fear Conditioning test, Exercise Wheel test)
- Mouse glucose measurement, brain and tissue extraction

Computational:

- Deep learning (TensorFlow, PyTorch), machine learning and natural language processing
- Multivariate analysis and statistical modeling
- Python, MATLAB, R, Java, C/C++, Linux/HPC

Imaging:

- MRI (structural, diffusion, perfusion, functional) for preclinical and clinical devices
- PET, SPECT imaging

Teaching and Research Experience

Duke Engineering Graduate Ambassador, Duke University, USA August 2023 – May 2025

- Guided prospective engineering graduate students, including international and underserved applicants, through Ph.D. application process.

Graduate Teaching Assistant, Duke University, USA January 2023 – December 2023

- Assisted in graduate-level courses, including *Medical Software Design* and *Cardiac Ultrasound Imaging and Function,* by grading coursework, supporting students with coding assignments, leading discussion sections, and providing additional support outside of class.

Summer Undergraduate Research, Seoul National University, Korea June 2018 – August 2018

Advisor: Jae Sung Lee, Ph.D.

- Evaluated the performance of detector modules for a second-generation transformable PET, including designing circuit schematics and implementing PCB for signal amplification, integrating experimental hardware development with analytical evaluation.

Undergraduate Research, Washington University in St. Louis, USA January 2018 – May 2018

Advisor: ShiNung Ching, Ph.D.

- Assisted in developing a novel EEG detection method for coma injury, including signal filtering methods that improved classification accuracy between normal and injured patients.

Operations Administrative Staff, Republic of Korea Army, Korea September 2014 –June 2016

- Served as sergeant and squad leader in Capital Mechanized Infantry Division, responsible for strategic planning and management. Received multiple commendations for exemplary service.

Publications

1. Moon, H. S., Han, Z. Y., Anderson, R. J., Mahzarnia, A., Stout, J. A., Niculescu, A. R., Tremblay, J. T., & Badea, A. (2025). ***Olfactory-Guided Behavior Uncovers Imaging and Molecular Signatures of Alzheimer's Disease Risk***. *Brain Sciences, 15*(8), 863.
2. Moon, H. S., Mahzarnia, A., Stout, J., Anderson, R. J., Han, Z. Y., Tremblay, J. T., Badea, C. T., & Badea, A. (2024). ***Feature attention graph neural network for estimating brain age and identifying important neural connections in mouse models of genetic risk for Alzheimer's disease***. *Imaging Neuroscience*, *2*, 1-22.
3. Moon, H. S., Mahzarnia, A., Stout, J. A., Anderson, R. J., Strain, M., Tremblay, J. T., ... & Badea, A. (2023). ***Multivariate investigation of aging in mouse models expressing the Alzheimer's protective APOE2 allele: integrating cognitive metrics, brain imaging, and blood transcriptomics. Brain Structure and Function****, 229*(1),231-249.
4. Moon, H. S., Heffron, L., Mahzarnia, A., Obeng-Gyasi, B., Holbrook, M., Badea, C. T., Feng, W., & Badea, A. (2022). ***Automated multimodal segmentation of acute ischemic stroke lesions on clinical MR images***. *Magnetic Resonance Imaging, 92,* 45-57.
5. Bridgeford, E. W., Chung, J., Anderson, R. J., Mahzarnia, A., Stout, J. A., Moon, H. S., Han, Z. Y., Vogelstein, J. T., & Badea, A. (2025). ***Network biomarkers of Alzheimer's disease risk derived from joint volume and texture covariance patterns in mouse models***. *PLoS One, 20*(8), e0327118.
6. Badea, A., Mahzarnia, A., Reddy, D., Dong, Z., Anderson, R. J., Moon, H. S., ... & Williams, C. L. (2025). ***Neuroimaging biomarkers of neuroprotection: Impact of voluntary versus enforced exercise in Alzheimer's disease models***. *Magnetic Resonance Imaging, 121*, 110406.
7. Winter, S., Mahzarnia, A., Anderson, R. J., Han, Z. Y., Tremblay, J. T., Stout, J. A., Moon, H. S., Marcellino, D., Dunson, D. B., & Badea, A. (2024). ***Brain network fingerprints of Alzheimer's disease risk factors in mouse models with humanized APOE alleles***. *Magnetic Resonance Imaging, 33*(9), 5307–5322.
8. Mahzarnia, A., Stout, J. A., Anderson, R. J., Moon, H. S., Yar Han, Z., Beck, K., ... & Badea, A. (2023). ***Identifying vulnerable brain networks associated with Alzheimer's disease risk***. *Cerebral Cortex*.
9. Liu, Z., Moon, H. S., Li, Z., Laforest, R., Perlmutter, J. S., Norris, S. A., & Jha, A. K. (2022). ***A tissue-fraction and estimation-based segmentation method for quantitative dopamine transporter SPECT***. *Medical Physics*, *49*(8), 5121-5137.

Conference Presentations and Invited Talks

1. Moon, H. S., Mahzarnia, A., Stout, J., Anderson, R. J., Han, Z. Y., Badea, C. T., & Badea, A. (2024). Predicting brain age and associated structural networks in mouse models with humanized APOE alleles using integrative and interpretable graph neural networks. *SPIE Medical Imaging 2024: Computer-Aided Diagnosis.*
2. Moon, H. S., Mahzarnia, A., Stout, J., Anderson, R. J., Han, Z. Y., & Badea, A. (2024). Estimating brain age and identifying important neural connections in mouse models of genetic risk for Alzheimer's disease. *International Society for Magnetic Resonance in Medicine (ISMRM) 2024*.
3. Moon, H. S., Heffron, L., Mahzarnia, A., Obeng-Gyasi, B., Holbrook, M., Badea, C. T., Feng, W., & Badea, A. (2023). Deep learning-based stroke segmentation and patient outcome prediction. *International Society for Magnetic Resonance in Medicine (ISMRM) 2023*.
4. Moon, H. S., Liu, Z., Ponisio, M., Laforest, R., & Jha, A. K. (2020). A physics-guided and learning-based estimation method for segmenting 3D DaT-Scan SPECT images. *Journal of Nuclear Medicine, 61*(supplement 1), pp.10-10.

5. Moon, H. S., Liu, Z., Laforest, R., Ponisio, M., & Jha, A. K. (2019). A deep-learning-based method for 3D segmentation of DaTScan SPECT Images. *World Molecular Imaging Congress (WMIC) 2019*.
6. Meyer-Baese, A., Muelle, K., Moon, H. S., Nagamani, G., Meyer-Baese, U., Bistrian, D. A., Stadlbauer, A., & Malberg, H. (2024). Controllability and robustness of functional and structural connectomic networks in dementia. *SPIE Medical Imaging 2024: Clinical and Biomedical Imaging*
7. Meyer-Baese, A., Muelle, K., Moon, H. S., Nagamani, G., Meyer-Baese, U., Bistrian, D. A., Stadlbauer, A., & Malberg, H. (2024). Cluster synchronization in fractional-order dynamic dementia networks. *SPIE Medical Imaging 2024: Clinical and Biomedical Imaging*
8. Varga, I., Moon, H. S., Conrad, A., Holbrook, M., Niculescu, A. R., Lakshmanan, A., Anderson, R. J., Williams, C. L., Badea, C. T., So, P., & Badea, A. (2021). A comparison of three whole brain segmentation methods for in-vivo manganese enhanced MRI in animal models of Alzheimer's disease. *International Society for Magnetic Resonance in Medicine (ISMRM) 2021*.
9. Feature attention graph neural network, BRAINSOC 295T: Bass Connections in Brain & Society Research Team (Spring 2025), Duke University
10. Graph neural network in Alzheimer's Disease study, COMPSCI 390: Topics in Computer Science (Spring 2025), Duke University