

# SUSHRUT THORAT

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## CONTACT INFORMATION

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## MISSION

Understanding and building resource-constrained agents that can learn & function in the wild.

## RESEARCH AREAS

Lifelong learning, developmental science, decision making, recurrent computations, explainable AI.

## ACADEMIC TRAJECTORY

**Postdoc in Machine Learning** 2022 - now

*Institute of Cognitive Science, Osnabrück University, Germany*

Advisor: Tim Kietzmann

Focus: Neuroconnectionist models of visual representations & learning.

**Ph.D. in Cognitive Neuroscience** 2017 - 2021

*Donders Centre for Cognition, Radboud University, The Netherlands*

Advisors: Marius Peelen & Marcel van Gerven

Thesis: Smart Search - Investigations into human visual search in structured environments.

**M.Sc. (cum laude) in Cognitive Neuroscience** 2015 - 2017

*Center for Mind/Brain Sciences (CIMEC), University of Trento, Italy*

Advisor: Marius Peelen

Thesis: Using Convolutional Neural Networks to measure the contribution of visual features to the representation of object animacy in the brain.

**B.Tech. in Engineering Physics** 2011 - 2015

*Department of Physics, Indian Institute of Technology - Bombay (IIT-B), India*

Advisor: Bipin Rajendran

Thesis: Quadcopter Flight Control using Modular Spiking Neural Networks.

## KEY PUBLICATIONS

**A full list of publications can be accessed at the end of this CV, or on [Google Scholar](#). Short descriptions of these projects can be found on my [website](#).**

Thorat S\*, Aldegheri G\*, Kietzmann TC (2021). Category-orthogonal object features guide information processing in recurrent neural networks trained for object categorization. *Shared Visual Representations in Human & Machine Intelligence Workshop @ NeurIPS*. \*equal contribution.

Thorat S, Proklova D, Peelen MV (2019). The nature of the animacy organization in human ventral temporal cortex. *eLife* 8: e47142.

Anthes D\*, Thorat S\*, Konig P, Kietzmann TC (2024). Keep Moving: identifying task-relevant subspaces to maximise plasticity for newly learned tasks. *Conference on Lifelong Learning Agents (CoLLAs)*. \*equal contribution.

Thorat S, Quek GL, Peelen MV (2022). Statistical learning of distractor co-occurrences facilitates visual search. *Journal of Vision* 22(10), 2-2.

Piefke L, Doerig A, Kietzmann T, Thorat S (2024). Computational characterization of the role of an attention schema in controlling visuospatial attention. *Annual Meeting of the Cognitive Science Society* (Vol. 46).

## TECHNICAL EXPERIENCE

**Programming languages**: Python, MATLAB, Javascript

**Machine learning frameworks**: TensorFlow, PyTorch, MatConvNet

**Experimentation frameworks**: PsychToolbox, jsPsych, Pavlovio

## Imaging techniques: fMRI, EEG, EyeLink

### CONFERENCE TALKS

Category-orthogonal object features guide information processing in recurrent neural networks trained for object categorization.

(Talk) *European Conference on Vision Perception (ECVP)*, Nijmegen, 2022

(Flash talk) *Neuromatch conference 4.0*, Online, 2021

Body silhouettes as features in visual search: evidence from spatially-global attention modulation in visual cortex.

(Talk) *Neuromatch conference 3.0*, Online, 2020

The functional role of cue-driven feature-based feedback in object recognition.

(Talk) *Perception Day*, Nijmegen, 2018

Using convolutional neural networks to measure the contribution of visual features to the representation of object animacy in the brain.

(Talk) *Rovereto Workshop on Concepts, Actions and Objects (CAOs)*, Rovereto, 2017

### ACHIEVEMENTS/ AWARDS

- Voted **best poster/short-pitch**, among **15 posters**, in the 'Perception, Action, and Control' theme at the annual Donders Poster Session (2020).
- Recipient of the **Merit Award** (2017), awarded to students who achieve remarkable results at the end of their degree, by the University of Trento, Italy.
- Recipient of the **Abstract Award**, awarded to **5 of the 57** accepted abstracts at the Rovereto Workshop on Concepts, Actions and Objects (2017).
- Ranked **721 among 450,000** students in the Joint Entrance Examination (**JEE, 2011**) conducted towards admission to the Indian Institute of Technology (IIT).
- Recipient of the **KVPY scholarship** (2009), awarded to **215 students across India** with talent and aptitude for research, by the Dept. of Science & Technology, Govt. of India.
- Recipient of the **NTSE scholarship** (2007), awarded to **1000 students across India** with high intellect and academic talent, by the National Centre for Educational Research and Technology, Govt. of India.

### REVIEWING WORK

Nature Human Behavior, Neural Networks, PLOS Computational Biology, Nature Communications, Science Advances, NeurIPS, ICLR, Memory & Cognition, eLife, iScience, CCN

### SUPERVISION EXPERIENCE

Supervised 11 undergraduate, 3 masters, and 3 PhD students. Notable theses are listed.

- (Bachelors) Jonas Bieber: *Leveraging reinforcement learning to generate natural reaction times from image-classifying RNNs.* Osnabrück University, 2024
- (Bachelors) Lotta Piefke: *Investigating the practicality and emergence of the Attention Schema Theory.* Osnabrück University, 2023
- (Masters) Jochem Koopmans: *How our predictions do not deceive us: an investigation of the illusory perception of upside-down letters.* Radboud University, 2022
- (Bachelors) Sjoerd Meijer & Ilze Thoonen: *Primed modulation of low-level object features using real-world objects and scenes.* Radboud University, 2018

### TEACHING EXPERIENCE

- **Lecturer:** *Reading group on cognitive abilities in artificial systems* (design, supervision, & evaluation; Masters) Osnabrück University, 2024
- **Lecturer:** *Reading group on integrative systems approaches in computational cognitive neuroscience* (design, supervision, & evaluation; Masters) Osnabrück University, 2024
- **Co-lecturer:** *Neuromatch Academy (NeuroAI course)* Online, 2024
- **Lecturer:** *Topics in cognitive neuroscience* (design, teaching, & evaluation; Masters) Osnabrück University, 23-24
- **Lecturer:** *Machine learning for cognitive computational neuroscience* (teaching, & evaluation; Masters) Osnabrück University, 2023

- **Lecturer:** *Reading group at the intersection of neuroscience & machine learning (design, supervision, & evaluation; Masters)* *Osnabrück University, 2023*
- **Mentor:** *Neuromatch Academy (Deep Learning course)* *Online, 2022*
- **Teaching Assistant:** *Advanced Academic & Professional Skills (evaluation; Masters)* *Radboud University, 2020*
- **Teaching Assistant:** *Neural Networks (supervision & evaluation; Bachelors)* *Radboud University, 2019*
- **Guest Lecturer:** *Academic Skills 2 (teaching & evaluation; Bachelors)* *Radboud University, 18-19*
- **Teaching Assistant:** *Brain for AI (supervision & evaluation; Bachelors)* *Radboud University, 2018*

#### WORKSHOPS ATTENDED

**Analytical Connectionism (AC)** *September, 2023*  
*Gatsby Computational Neuroscience Unit, United Kingdom*  
Project: Visual feature manifolds in a convolutional RNN.

**IBRO-SIMONS Computational Neuroscience Imbizo (ISi-CNI)** *January, 2017*  
*University of Cape Town, South Africa*  
Project: Assessing the role of feature attention in object detection with CNNs.

**Computational Approaches to Memory and Plasticity (CAMP)** *June, 2015*  
*National Centre for Biological Sciences, India*  
Project: The role of the billions of granule cells in the cerebellum.

#### INVITED TALKS

Behaving RNNs: Bridging the gap between naturalistic evidence and decision-making.  
 (Lab retreat talk) *Cichy lab, FU, Berlin, 2024*

Useful scene representations.  
 (Lab meeting talk) *Kaiser lab, JLU, Giessen, 2023*

Category-orthogonal object features guide information processing in recurrent neural networks trained for object categorization.  
 (Guest talk) *MSc course on Advanced Neural and Cognitive Modelling, UvA, Amsterdam, 2022*

Representations: Useful, useless or harmful?  
 (Seminar talk) *Foundations of Cognition Series, Donders Institute, Nijmegen, 2019*

#### OTHER WORK EXPERIENCE

**General Secretary** *2014-15*  
*Undergraduate division - Department of Physics, IIT Bombay*

**Content Developer** *Summer 2013*  
*Avanti Fellows, Delhi*

### Full list of Publications

#### Peer-reviewed Journal Research Papers (\* indicates equal contribution)

Yeh, L. C., Thorat, S., & Peelen, M. V. (2024). Predicting cued and oddball visual search performance from fMRI, MEG, and DNN neural representational similarity. *Journal of Neuroscience*, 44(12). <https://doi.org/10.1523/JNEUROSCI.1107-23.2024>

Gayet, S., Battistoni, E., Thorat, S., & Peelen, M. V. (2024). Searching near and far: The attentional template incorporates viewing distance. *Journal of Experimental Psychology: Human Perception and Performance*, 50(2), 216. <https://doi.org/10.1167/jov.23.9.4686>

Thorat, S., Quek, G. L., & Peelen, M. V. (2022). Statistical learning of distractor co-occurrences facilitates visual search. *Journal of Vision*, 22(10), 2-2. <https://doi.org/10.1167/jov.22.10.2>

Thorat, S., & Peelen, M. V. (2022). Body shape as a visual feature: Evidence from spatially-global attentional modulation in human visual cortex. *NeuroImage*, 255, 119207. <https://doi.org/10.1016/j.neuroimage.2022.119207>

Thorat, S., Proklova, D., & Peelen, M. V. (2019). The nature of the animacy organization in human ventral temporal cortex. *Elife*, 8, e47142. <https://doi.org/10.7554/eLife.47142>

#### Peer-reviewed Journal Comment Papers

Luppi, A. I.\*, Achterberg, J.\*, Schmidgall, S., ... , Thorat, S. et al. (2024) Trainees' perspectives and recommendations for catalyzing the next generation of NeuroAI researchers. *Nature Communications* 15, 9152. <https://doi.org/10.1038/s41467-024-53375-2>

#### Peer-reviewed Conference Research Papers

##### Long Papers (> 4 pages)

Piefke, L. M., Doerig, A., Kietzmann, T., & Thorat, S. (2024). Computational characterization of the role of an attention schema in controlling visuospatial attention. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 46). <https://escholarship.org/uc/item/1516x0js>

Anthes, D.\*, Thorat, S.\*, Kietzmann, T. C., & König, P. (2024). Keep Moving: identifying task-relevant subspaces to maximise plasticity for newly learned tasks. In *3rd Conference on Lifelong Learning Agents (CoLLAs)*. <https://openreview.net/forum?id=A5CQcb5PwQ>

Thorat, S.\*, Aldegheri, G.\*, & Kietzmann, T. C. (2021). Category-orthogonal object features guide information processing in recurrent neural networks trained for object categorization. In *SVRHM 2021 Workshop @ NeurIPS*. [https://openreview.net/forum?id=BJpv46DGNl\\_](https://openreview.net/forum?id=BJpv46DGNl_)

Thorat, S., & Choudhari, V. (2016). Implementing a Reverse Dictionary, based on word definitions, using a Node-Graph Architecture. In *Proceedings of COLING 2016, the 26th International Conference on Computational Linguistics: Technical Papers* (pp. 2797-2806). <https://aclanthology.org/C16-1263>

Thorat, S., & Rajendran, B. (2015). Arithmetic computing via rate coding in neural circuits with spike-triggered adaptive synapses. In *2015 International Joint Conference on Neural Networks (IJCNN)* (pp. 1-8). IEEE. <https://doi.org/10.1109/IJCNN.2015.7280822>

### Short Papers ( $\leq 4$ pages)

Singer, J. J., Cichy, R. M., Kietzmann, T. C., & Thorat, S. (2024) Contrasting computational models of task-dependent readout from the ventral visual stream. In *2024 Conference on Cognitive Computational Neuroscience*. [https://2024.ccneuro.org/pdf/98\\_Paper\\_authored\\_submission\\_non\\_anonymous.pdf](https://2024.ccneuro.org/pdf/98_Paper_authored_submission_non_anonymous.pdf)

Anthes, D., Thorat, S., König, P., & Kietzmann, T. C. (2024) Continual learning in artificial neural networks as a computational framework for understanding representational drift in neuroscience. In *2024 Conference on Cognitive Computational Neuroscience*. [https://2024.ccneuro.org/pdf/567\\_Paper\\_authored\\_CCN2024-authored.pdf](https://2024.ccneuro.org/pdf/567_Paper_authored_CCN2024-authored.pdf)

Bosch, V., Gutlin, D., Doerig, A., Anthes, D., Thorat, S., König, P., & Kietzmann, T. C. (2024) CorText: large language models for cross-modal transformations from visually evoked brain responses to text captions. In *2024 Conference on Cognitive Computational Neuroscience*. [https://2024.ccneuro.org/pdf/526\\_Paper\\_authored\\_Cortext\\_Bosch\\_CCN2024.pdf](https://2024.ccneuro.org/pdf/526_Paper_authored_Cortext_Bosch_CCN2024.pdf)

Anthes, D., Thorat, S., Kietzmann, T. C., & König, P. (2023). Diagnosing Catastrophe: Large parts of accuracy loss in continual learning can be accounted for by readout misalignment. In *2023 Conference on Cognitive Computational Neuroscience*. [https://2023.ccneuro.org/view\\_paper0f17.html?PaperNum=1256](https://2023.ccneuro.org/view_paper0f17.html?PaperNum=1256)

Thorat, S., Doerig, A., & Kietzmann, T. C. (2023). Characterising representation dynamics in recurrent neural networks for object recognition In *2023 Conference on Cognitive Computational Neuroscience*. [https://2023.ccneuro.org/view\\_paperde47.html?PaperNum=1088](https://2023.ccneuro.org/view_paperde47.html?PaperNum=1088)

Thorat, S.\*, Aldegheri, G.\*, Van Gerven, M. A., & Peelen, M. V. (2019). Modulation of early visual processing alleviates capacity limits in solving multiple tasks. In *2019 Conference on Cognitive Computational Neuroscience*. <https://2019.ccneuro.org/proceedings/0000226.pdf>

Thorat, S., Van Gerven, M. A., & Peelen, M. V. (2018). The functional role of cue-driven feature-based feedback in object recognition. In *2018 Conference on Cognitive Computational Neuroscience*. <https://2018.ccneuro.org/proceedings/1044.pdf>