

# PROF. THOMAS S. A. WALLIS, PHD

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## RESEARCH INTERESTS

Somehow, our minds make sense of sensory data in a way that eludes current machine vision systems. I study visual perception in humans, and compare the inferences of humans and machines to gain stronger insights into both biological and artificial seeing. My research program combines the traditions of experimental psychology and psychophysics with recent advances in AI and machine learning. I aim to understand the computational principles that underlie our brains' ability to combine sensory inputs to generate holistic perceptual experience ("why things look as they do"; Koffka, 1935). I study, or have previously studied, scene appearance, eye movements, crowding, motion-induced blindness, binocular rivalry, contrast perception, macular degeneration, and hazard perception in driving. I do my best to make my research reproducible and encourage open scientific practices.

## EDUCATION & EMPLOYMENT

2021–Present	Full Professor (W3) <i>Technical University of Darmstadt</i>
01/2019–03/2021	Senior Research Scientist <i>Amazon Development Center Germany GmbH</i>
01/2017–05/2019	Project Leader, Collaborative Research Centre (SFB) 1233 "Robust Vision" <i>Centre for Integrative Neuroscience, The University of Tübingen</i>
06/2018–10/2018	Parental leave
10/2017–10/2018	Acting Professor (Vertretungsprofessor, W3) <i>The University of Tübingen</i>
2013–2016	Humboldt Postdoctoral Fellow, Bethge & Wichmann Laboratories <i>The University of Tübingen</i>
2011–2013	National Health and Medical Research Council of Australia (NHMRC) Training Fellow <i>Bex lab, Schepens Eye Research Institute, Harvard Medical School</i>
2010–2011	Postdoctoral Fellow (NIH grant EY019281) <i>Bex lab, Schepens Eye Research Institute, Harvard Medical School</i>
2007–2010	PhD (Psychology) "Pencils and erasers: Interactions between motion and spatial coding in human vision" Advisor: Prof. Derek Arnold. Associates: Prof. Jason Mattingley & Prof. Ottmar Lipp. <i>The University of Queensland, Australia</i>
2001–2004	Bachelor of Psychological Science (Hons I) Undergraduate thesis title: "Hazard perception in driving". Advisor: Prof. Mark Horswill. <i>School of Psychology, The University of Queensland (Australia)</i>

## AWARDS AND FUNDING

- 2023 European Research Council Consolidator Grant, 2023–2028, 2.1 mi €
- 2022 Networking grant for collaboration between Hesse, Queensland, Massachusetts and Wisconsin (Vernetzungsaktivitäten mit Universitäten der Landesprogramme in Wisconsin, Massachusetts und Queensland; Hessisches Ministerium für Wissenschaft und Kunst); 11,250 €.
- 2018 Teaching award from the Graduate Training Centre for Neuroscience, Uni Tübingen (awarded by GTC Masters students for the course “Psychophysics and Non-invasive Methods”, Summer Semester 2018).
- 2017–2020 Project leader, Collaborative Research Centre (Sonderforschungsbereich) 1233 “Robust Vision” (approx. €8 mil. for 14 projects over four years; my project €276,400)
- 2013–2016 Humboldt Research Fellowship for Postdoctoral Researchers (extended to three years due to parental responsibilities)
- 2013 Marie Curie International Incoming Fellowship, declined in favour of Humboldt fellowship
- 2010 NHMRC Postgraduate Training Award. \$394,559 support over four years (relinquished after two, to move to Germany)
- 2008 Winner, Postgraduate Student Research Excellence Award, School of Psychology, The University of Queensland
- Australasian Experimental Psychology Conference Student Award
- Selected to attend the European Visual Neuroscience Summer School, Rauischolzhausen, Germany
- 2004 University Medal for undergraduate degree (awarded to the top 1% of UQ graduates annually). Equivalent to *Summa Cum Laude*.

## PUBLICATIONS

Equal contributions by several authors indicated by †. Equal senior authorship indicated as ‡.

### JOURNAL AND CONFERENCE PUBLICATIONS

- 2022 Kümmerer, M., Bethge, M.†‡ & Wallis, T.S.A.†‡ (2022). DeepGaze III: Modelling Free-Viewing Human Scanpaths with Deep Learning. *Journal of Vision*, 22(7) ([Link](#)).
- Pedziwiatr, M. A., Kümmerer, M., Wallis, T. S. A., Bethge, M., & Teufel, C. (2022). Semantic object-scene inconsistencies affect eye movements, but not in the way predicted by contextualized meaning maps. *Journal of Vision*, 22(2), 9. ([Link](#))
- Rideaux, R., West, R. K., Wallis, T. S. A., Bex, P. J., Mattingley, J. B., & Harrison, W. J. (2022). Spatial structure, phase, and the contrast of natural images. *Journal of Vision*, 22(1), 4. ([Link](#)).
- 2021 Zimmermann, R. S.†, Borowski, J.†, Geirhos, R., Bethge, M.†, Wallis, T. S. A.†, & Brendel, W.†. (2021). How Well do Feature Visualizations Support Causal Understanding of CNN Activations? *Neural Information Processing Systems (NeurIPS)*. ([Link](#)). Accepted as a **Spotlight** (< 3% of submissions).
- Funke, C. M.†, Borowski, J.†, Stosio, K., Brendel, W.†, Wallis, T. S. A.†, & Bethge, M.†. (2021). Five points to check when comparing visual perception in humans and machines. *Journal of Vision*, 21(3), 16. ([Link](#)).

- Lukashova-Sanz, O., Wahl, S., Wallis, T. S. A., & Rifai, K. (2021). The Impact of Shape-Based Cue Discriminability on Attentional Performance. *Vision*, 5(2), 18. ([Link](#)).
- Borowski, J.<sup>†</sup>, Zimmermann, R. S.<sup>†</sup>, Schepers, J., Geirhos, R., Wallis, T. S. A.<sup>‡</sup>, Bethge, M.<sup>‡</sup>, & Brendel, W.<sup>‡</sup> (2021). Exemplary Natural Images Explain CNN Activations Better than State-of-the-Art Feature Visualizations. *International Conference on Learning Representations (ICLR)*.
- Pedziwiatr, M. A., Kümmerer, M., Wallis, T. S. A., Bethge, M. & Teufel, C. (2021). Meaning maps and saliency models based on deep convolutional neural networks are insensitive to image meaning when predicting human fixations. *Cognition*, 206 (104465). ([Link](#), [Reply](#), [Reply to reply](#)).
- 2020 Tangemann, M., Kümmerer, M., Wallis, T. S. A. & Bethge, M. (2020). Measuring the importance of temporal features in video saliency. *The European Conference on Computer Vision (ECCV)*.
- 2019 Wallis, T. S. A.<sup>†</sup>, Funke, C. M.<sup>†</sup>, Ecker, A. S., Gatys, L. A., Wichmann, F. A., & Bethge, M. (2019). Image content is more important than Bouma's Law for scene metamers. *ELife*, 8, e42512. ([Link](#)).
- 2018 Kümmerer, M., Wallis, T.S.A. & Bethge, M. (2018). Saliency Benchmarking Made Easy: Separating Models, Maps and Metrics. *The European Conference on Computer Vision (ECCV)—Selected as an oral presentation*. ([link to arXiv version](#)).
- 2017 Wallis, T.S.A., Funke, C.M., Ecker, A.S., Gatys, L.A., Wichmann, F.A., & Bethge, M. (2017). A parametric texture model based on deep convolutional features closely matches texture appearance for humans. *Journal of Vision*, 17(12):5. ([link](#), [preprint](#), [code and raw data](#), [stimuli](#))
- Kümmerer, M., Wallis, T.S.A., Gatys, L.A., & Bethge, M. (2017). Understanding Low- and High-Level Contributions to Fixation Prediction. *The IEEE International Conference on Computer Vision (ICCV), 2017*. ([pdf](#), [download models](#), [web service](#))
- Wallis, T.S.A., Tobias, S., Bethge, M. & Wichmann, F.A. (2017). Detecting distortions of peripherally-presented letter stimuli under crowded conditions. *Attention, Perception and Psychophysics*. ([publisher link](#), [open pdf](#), [code and data](#), [correction](#))
- 2016 Wallis, T.S.A., Bethge, M. & Wichmann, F. A. (2016). Testing models of peripheral encoding using metamerism in an oddity paradigm. *Journal of Vision*, 16(2), 4. ([link](#), [code](#), [data and materials](#))
- 2015 Kümmerer, M., Wallis, T.S.A. & Bethge, M. (2015). Information-theoretic model comparison unifies saliency metrics. *Proceedings of the National Academy of Sciences* 112(52), 16054–16059. ([link](#), [code](#))
- Wallis, T.S.A.<sup>†</sup>, Dorr, M.A.C.<sup>†</sup> & Bex, P.J. (2015). Sensitivity to gaze-contingent contrast increments in naturalistic movies: An exploratory report and model comparison. *Journal of Vision*, 15(8), 3. ([link](#), [code and data](#))
- 2014 Wallis, T.S.A., Taylor, C.P., Wallis, J., Jackson, M.L. & Bex, P.J. (2014). Characterisation of field loss based on microperimetry is predictive of face recognition difficulties. *Investigative Ophthalmology & Visual Science*, 55(1), 142–153. ([pdf](#), [supp](#), [code and data](#))
- 2012 Wallis, T.S.A. & Bex, P.J. (2012). Image correlates of crowding in natural scenes. *Journal of Vision*, 12(7): 6, 1–19. ([link](#))
- 2011 Wallis, T.S.A. & Bex, P.J. (2011). Visual crowding is correlated with awareness. *Current Biology*, 21(3): 254–258. ([pdf](#), [Supp](#))
- 2010 Arnold, D.H., Erskine, H., Roseboom, W. & Wallis, T.S.A. (2010). Spatio-Temporal Rivalry: A perceptual conflict involving illusory moving and static forms. *Psychological Science*, 21(5):

692–9. ([pdf](#))

- 2009 Wallis, T.S.A., Williams, M.A. & Arnold, D.H. (2009). Pre-exposure to moving form enhances static form sensitivity. *PLoS ONE*, 4(12): e8324. ([link](#))
- Wallis, T.S.A. & Arnold, D.H. (2009). Motion-induced blindness and motion streak suppression. *Current Biology*, 19(4): 325–329. ([pdf](#))
- 2008 Wallis, T.S.A. & Arnold, D.H. (2008). Motion-induced blindness is not tuned to retinal speed. *Journal of Vision*, 8(2): 11, 1–7. ([pdf](#))
- Arnold, D.H., Birt, A., & Wallis, T.S.A. (2008). Perceived Size and Spatial Coding. *Journal of Neuroscience*, 28(23): 5954–5958. ([pdf](#))
- Arnold, D.H., Law, P. & Wallis, T.S.A. (2008). Binocular Switch Suppression: A new method for persistently rendering the visible ‘invisible’. *Vision Research*, 48(8): 994–1001. ([pdf](#))
- 2007 Wallis, T.S.A. & Horswill, M.S. (2007). Using fuzzy signal detection theory to determine why experienced and trained drivers respond faster than novices in a hazard perception test. *Accident Analysis & Prevention*, 39(6), 1177–1185. ([pdf](#))
- Arnold, D.H., Grove, P.M. & Wallis, T.S.A. (2007). Staying focussed: A functional account of perceptual suppression during binocular rivalry. *Journal of Vision*, 7(7):7, 1–8. ([link](#))

#### PATENTS

I am a co-inventor on the following US Patents. In all cases, the patent holder is Amazon Technologies, Inc., and I have relinquished all intellectual ownership rights over these technologies.

- 2023 Wallis, T. S. A., Staudigl, L., Javed, M. B., Barbachano, P., & Mueller, M. (2023). Perceived media object quality prediction using adversarial annotations for training and multiple-algorithm scores as input (Patent No. US11544562).
- 2022 Staudigl, L., Wallis, T. S. A., Mueller, M., Javed, M. B., & Barbachano, P. (2022). Iterative media object compression algorithm optimization using decoupled calibration of perceptual quality algorithms (Patent No. US11527019).
- Sternig, S., Staudigl, L., Barbachano, P., Wallis, T. S. A., Javed, M. B., & Donoser, M. (2022). Image cropping using pre-generated metadata (Patent No. US11361447).

#### WORKSHOP PUBLICATIONS

- 2019 Borowski, J., Funke, C. M., Stosio, K., Brendel, W., Wallis, T. S. A. & Bethge, M. (2019). The Notorious Difficulty of Comparing Human and Machine Perception. *NeurIPS Workshop on Shared Visual Representations in Human and Machine Intelligence*. ([Link](#)). [**Best paper award**]

#### PREPRINTS (UNREVIEWED)

- 2017 Gatys, L. A., Kümmerer, M., Wallis, T.S.A. & Bethge, M. (2017). Guiding human gaze with convolutional neural networks. *arXiv:1712.06492* ([link](#))

## INVITED TALKS AND GUEST LECTURES

- 2023 Neural Information Processing group, Universität Tübingen. “Artificial neural networks as approximate ideal observers”. February 3, 2023.  
Department of Psychology, Justus-Liebig-Universität Gießen. “Artificial neural networks as approximate ideal observers”. January 11, 2023.
- 2020 Keynote speaker for Workshop on Eye Tracking for Quality of Experience in Multimedia (ET-MM) “Predicting eye movements in images and video: Recent progress and future challenges”. June 2, 2020. Workshop part of ACM Symposium on Eye Tracking Research & Applications (ETRA). [Workshop website](#).
- 2019 Invited tutorial at the 2019 European Conference on Visual Perception “Bayesian mixed-effects models for psychophysical data: A tutorial with R and brms”. August 25, 2019. [Tutorial materials](#).
- 2016 Medical Research Council Cognition and Brain Sciences Unit, Cambridge UK. “Deep features capture natural image statistics important for human perception”. October 19, 2016.  
Twitter Cortex (Twitter Inc.), London UK. “Deep features capture natural image statistics important for human perception”. October 18, 2016.
- 2014 Department of Psychology, Ludwig-Maximilians-Universität München. “Probing peripheral visual representations”. November 19, 2014.
- 2013 Centre for Perception and Cognitive Neuroscience, The University of Queensland. “Sensitivity to gaze-contingent modifications of image structure in freely-viewed naturalistic movies: contrast and spatial distortions”. April 2013.
- 2012 Radcliffe Symposium, Harvard University. “Reading: Clinical Rehabilitation and Neuro-Plasticity”. September 17–18, 2012.
- 2008 Dean’s Scholars’ Seminar, The University of Queensland. “Moving objects can alter your consciousness”. 2008.

## TEACHING

- 2022 “Wahrnehmen”, TU Darmstadt (6 SWS; B. Cognitive Science)  
“Foundations of Cognitive Science”, TU Darmstadt (2 SWS; B.Sc Cognitive Science)  
“Advanced topics in visual perception”, TU Darmstadt (2 SWS; M.Sc Cognitive Science)  
“Applied Cognitive Science”, TU Darmstadt (4 SWS; M.Sc Cognitive Science)
- 2021 “Wahrnehmen”, TU Darmstadt (8 SWS; B.Cognitive Science)
- 2018 Teaching award from the Graduate Training Centre for Neuroscience, Uni Tübingen. Awarded by students for “Psychophysics and Non-invasive Methods”, Summer Semester 2018.  
“Psychophysical Methods” (2 SWS; M.Sc)  
“Colour Vision and Material Perception” (2 SWS; M.Sc)  
“Psychophysics and Non-Invasive Methods” (2 SWS; M.Sc)
- 2017 “Visuelle Wahrnehmung für Informatiker” (4 SWS)
- 2015 “Advanced Statistics for Graduate Students”, Graduate School, The University of Tübingen (with Philipp Berens). [Course materials available here](#).
- 2009 Guest lecturer, “Sensory Neuroscience”, School of Psychology, The University of Queensland (Prof Jason Mattingley)

- 2007 Lead Tutor, “Research Methodology and Statistics I”, School of Psychology, The University of Queensland
- 2007 Tutor, “Research Methodology and Statistics I”, School of Psychology, The University of Queensland

## THESIS SUPERVISION

- 2017– Co-supervisor (with Matthias Bethge) of PhD students Christina Funke and Judith Borowski.
- 2018 Supervisor of Bachelor student project Freya Thießen, Masters rotation Marlene Weller.
- 2017 Supervisor of Bachelor student projects Anna Giron and Wiebke Ringels, Masters rotation Jonathan Oesterle.
- 2016 Co-supervisor (with Matthias Bethge) of M.Sc. student Christina Funke.  
Co-supervisor (with Felix Wichmann) of Bachelor thesis student Britta Lewke.  
Co-supervisor (with Matthias Bethge) of undergraduate intern Cordula Markert.
- 2014 Co-supervisor (with Felix Wichmann) of M.Sc. student Saskia Tobias.  
Co-supervisor (with Matthias Bethge) of undergraduate intern Annelie Mühler.

## PROFESSIONAL SERVICE & OUTREACH

### INSTITUTIONAL SERVICE

- Member of the Faculty Council (Fachbereichsrat) for the Department of Human Sciences, TU Darmstadt (2021–).
- Internationalisation Officer (Internationalisationsbeauftragte; joint with Loes van Dam), Department of Human Sciences, TU Darmstadt (2021–).
- Overseas exchange officer (Auslandsbeauftragten; joint with Loes van Dam), Department of Human Sciences, TU Darmstadt (2022–).
- Member of the examination board (Prüfungskommission) for Cognitive Science, Department of Human Sciences, TU Darmstadt (2023–).

### BOARD & SOCIETY MEMBERSHIPS

- Board Member, Psychology in Open Access (<http://psyoa.org>)
- Member, Vision Sciences Society
- Member of the Board of Reviewers, Journal of European Psychology Students (JEPS)

### EDITING & REVIEWING

I am an Editorial Board Member of Journal of Vision (since Jan 2023).

I have acted as a reviewer for the following venues at least once.

ACM Transactions on Applied Perception, Biology Letters, Cognitive Computational Neuroscience (CCN) Conference, Current Biology, European Conference on Computer Vision

(ECCV), Frontiers in Perception Science, Investigative Ophthalmology and Visual Science (IOVS), International Conference on Learning Representations (ICLR), Journal of Vision, Nature Communications, Neural Information Processing Systems (NeurIPS), Perception, Perspectives on Psychological Science, PloS Computational Biology, Proceedings of the National Academy of Sciences (PNAS), Psychological Review, SIGGRAPH Asia, Vision Research.

*Exceptional reviewer* Journal of Vision 2013, 2014, 2015, 2016, 2018 ( $\times 3$ ), 2020, 2021, 2022

*Exceptional reviewer* Investigative Ophthalmology and Visual Science (IOVS) 2015.

#### WORKSHOP AND COMMITTEE SERVICE

10/2016

Co-organiser of a workshop for early career vision scientists “What have vision scientists learned in the past five years?”, Cambridge, UK.

CV based on template by [Bastian Rieck](#).