Visual Representations

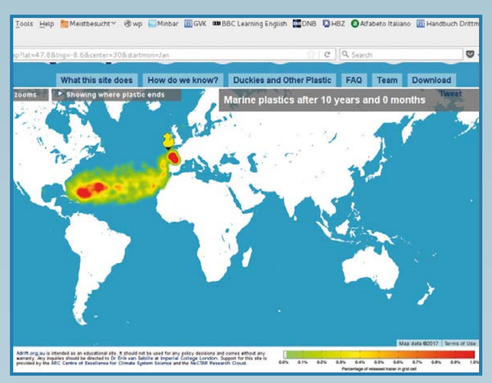
Navigating Epistemological Challenges and Merits

PD Dr. Nicola Mößner (visiting professor)

Visual representations (photographs, maps, diagrams, drawings etc.) play a major role in science. Depending on the context and user, they can have both epistemic and non-epistemic functions.

Visual representations are, for instance, important tools in scientific communication processes. They leverage our primary human sense (visual perception) to cognitively process information.
By doing so, they allow for perceptual learning that enables, for example:

1) Grasping of complex phenomena (e.g. ocean current)

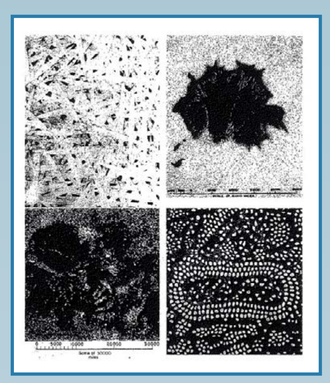


Source: https://plasticadrift.org/

2) Seeing reasons in visual arguments (e.g. melting glaciers)

Source: https://chasingice.com/thescience/

3) Acquisition and formation of concepts (e.g. granulation of solar surface)



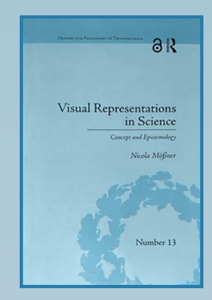
Source: Hentschel, K. 2000, 24

Research questions include e.g.:

- Can they be integral parts of scientific arguments?
- What kind of knowledge, propositional or non-propositional, can they convey, and why?
- Can they facilitate scientific understanding?

Selected Results

- Mößner, N.: "Gründe einsehen. Visuelle Repräsentationen im Prozess des wissenschaftlichen Verstehens". In: Bilder im Aufbruch: Herausforderungen der Bildwissenschaft, ed. by Lemmes, M. / Packard, S. / Sachs-Hombach, K., Cologne: von Halem Verlag 2025, pp. 153-180. CC-BY-NC-ND/4.0) https://elibrary.utb.de/doi/book/10.1453/9783869626888.
- Mößner, N.: Visual Representations in Science – Concept and Epistemology. London and New York: Routledge 2018, https://doi.org/10.4324/9781315108902.



- Chapter 4 "The epistemic status of scientific visualisations" of Mößner, N., "Visual Representations in Science – Concept and Epistemology" (Routledge 2018, pp. 209-332) Licence: CC-BY 4.0 https://doi.org/10.4324/9781315108902.

Philosophy of Photography

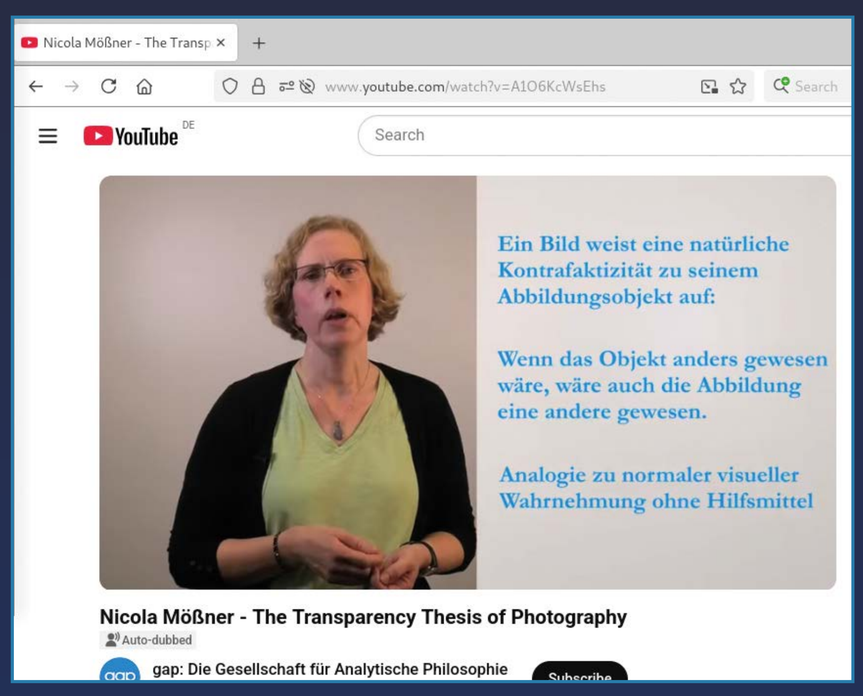
Since its invention, photography has been regarded as a particularly credible medium. Due to its allegedly indexical nature of image production, it was, for instance, embraced as a valuable tool in science. Beyond that, photography has been and continues to be used in a variety of contexts—from the art world to the media landscape, from everyday applications to the courtroom. The philosophy of photography seeks to provide an account of the phenomenon of photography across all these different realms.

Focusing on more recent debates, the following research questions are explored:

- Why is it helpful to think of 'photography' as 'a family of technologies'?
- What do proponents of the 'new theory of photography' claim?
- Why is it beneficial to consider photography as a multi-step process?
- Does post-processing turn photography into a kind of drawing?
- Does post-processing necessarily undermine the epistemic credibility of photographs?
- What are the consequences of digital photography concerning its (i) epistemology and (ii) aesthetics?
- What are deep fakes and how can we deal with them?

Selected Results

- Book project (under contract): Mößner, N.: Philosophie der Fotografie: Indexikalität - Technologie - Digitalität. Eine systematische Einführung. Under contract: Schwabe Verlag (Basel).
- GAP-Video (explaining concepts): Mößner, N.: The transparency thesis of photography explained. https://www.youtube.com/watch?v=A1O6KcWsEhs



Leibniz Universität Hannover

PD. Dr. Nicola Mößner
M.A. Kristina Malzahn

From Detection to Interpretation
The Epistemic Function of AI in Scientific Imaging

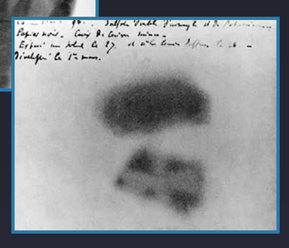
M.A. Kristina Malzahn (PhD candidate)

Transformation of the image function
Index (trace) → model visualisation → generative simulation

1895/96

Classical scientific images: Indexical coupling
(X-ray, photographic plate)

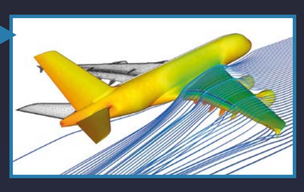
Not his wife's hand, but one of the first X-rays taken by Wilhelm Conrad Röntgen. Credit: deutschland-funkkultur.de, 2023.



First photographic plate blackened by 'Becquerel rays'. It was placed under a uranium salt on 26 February 1896. Credit: Becquerel, 2025.

1960

Model-based visualisations:
Simulations without direct optical coupling

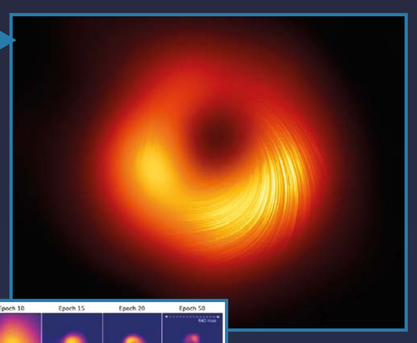


The image shows the result of a numerical flow simulation on an Airbus A380. Credit: Simulationsmodell 2024.

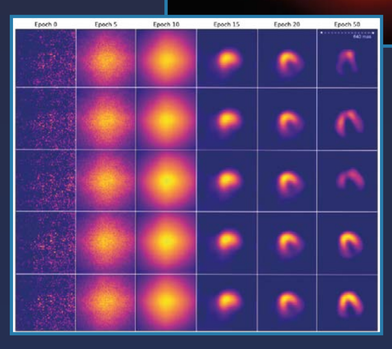
...

2022

AI-generated images:
Visibility from probability and latent spaces without reference to the world

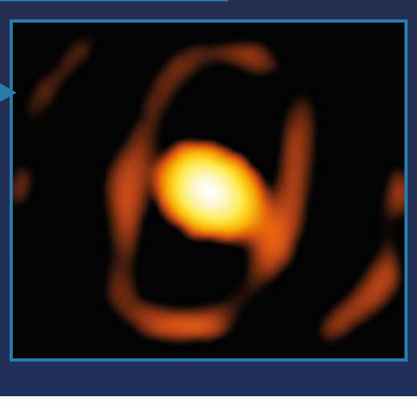


A view of the supermassive black hole in M87* in polarised light. Credit: ESO/EHT Collaboration (2021)



The image displays 25 panels with reconstructed images obtained with CASSINI-AUTOMAP. Every column shows 5 images at different epochs. Each panel covers an equivalent area of 640 × 640 mas. The emission is normalized to the peak of each image. Credit: Sanchez-Bermudez et al., 2022, 8.

2024



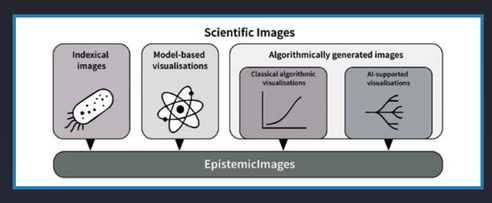
Algorithmically reconstructed image of WOH G64 at 2.2 µm. Credit: ESO/K. Ohnaka et al. (2024).

Research question

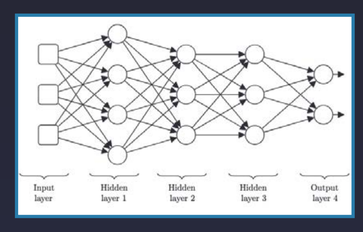
- How does the epistemic function of scientific images change when they are no longer based on a detective coupling to observable phenomena, but appear as machine-generated, epistemically unauthorised artefacts?

Background

The epistemic function of scientific images shifts when the detective coupling to empirically detectable phenomena is replaced by algorithmically generated visibility spaces of generative systems.

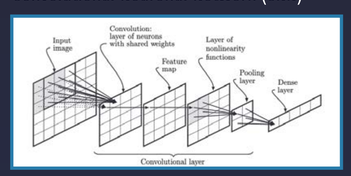


Technical processes such as CNN, GAN and CASSINI-AUTOMAP are examples of this transition from world reference to probability/ latent space.



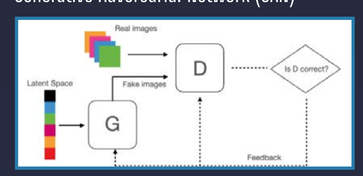
The image displays "Topological illustration of a simple neural network". Credit: Kelleher, 2019, 68.

Convolutional Neuronal Network (CNN)



Illustrations of the different stages of processing in a convolutional layer. Note in this figure the Image and Feature Map are data structures; the other stages represent operations on data.". Credit: Kelleher, 2019, 168.

Generative Adversarial Network (GAN)



Schematics of a Generative Adversarial Network (GAN). This type of neural network confronts two nets in a minmax game. The first one is the generator (G) which is going to create new samples of a signal from a compressed dimensional space (i.e., the latent space). The second one is the discriminator (D), which tries to determine whether the input from G is fake in comparison with a sample or real images.". Credit: Sanchez-Bermudez et al., 2022, 3.

Selected Results

- Visibility without trace: Generative visualisations create epistemically contingent spaces of possibility rather than referential evidence
- Hybrid authority: Epistemic authority is hybrid and arises from the responsible appropriation of AI systems
- Validity through practice: Validity does not arise in the image, but through argumentative embedding, transparency and collective review
- Performative plausibility ≠ validity: Technical quality measures similarity, not truth
- Under these conditions, knowledge does not arise as a product of machine image production, but through reflexive and responsible validation practices in social contexts.
- https://doi.org/10.15488/20747