Melanie Leidecker-Sandmann[1], Tabea Lüders[1], Carolin Moser[2], Vincent R. Boger[1], & Markus Lehmkuhl[1]

[1] Karlsruhe Institute of Technology, Department of Science Communication, Germany
[2] Karlsruhe Institute of Technology, Institute for Technology Assessment and Systems Analysis, Germany

More than humanoid robots and cyborgs? How German print media visualize articles on artificial intelligence

ABSTRACT: Engaging with the ongoing debate regarding the portrayal of artificial intelligence (AI) in the public sphere – particularly the alleged predominance of sci-fi imagery and humanoid robots – our study examines how six German print media visualize articles related to AI. A mixed-methods approach combines qualitative and quantitative visual content analysis, analyzing 818 images from articles published in 2019 and 2022/23. Our findings indicate that human figures, rather than robots, serve as dominant visual objects, and no significant image-to-text gaps were observed. Overall, German print media appear to present a nuanced perspective on AI, balancing opportunities and risks associated with this technology.

Keywords: Visual Communication; Visualization; Artificial Intelligence; Newspaper Coverage; Visual Content Analysis; Visual Framing

Context and Relevance

“Type ‘AI images’ into your search engine and you will notice a pattern [Better Images of AI, 2024; see also Romele, 2022]. The pattern that the NGO “Better Images of AI” is suggesting here is a predominance of sci-fi inspired and anthropomorphized images of Artificial Intelligence (AI), like humanoid robots or cyborgs, robots with brains respectively human brains with computer elements, outstretched robot hands (as variations of Michelangelo’s *The Creation of Adam*) or Terminator visualizations. This “clichéd” [Romele, 2022, p. 5] way to describe AI and a predominant usage of robot or sci-fi imagery is suspected and critically reflected by many other actors and researchers as well (e. g. [Guzman, 2017; Meinecke & Voss, 2018; Moretti & Rogers, 2022; Mustaklem, 2024, quoted from Adami, 2024; Romele, 2022; Schmitt, 2021]; or a project group called “AI Myths” [n.d.]).

Lately, a lively debate about potential problems of a lack of variety respectively the predominant use of sci-fi images to visualize AI has developed. The critics (for example AI researchers) argue, through an inappropriate visualization of AI public misconceptions can be generated and the public’s understanding of how AI systems are currently used or how they work, what potential and what limitations are associated with it, could be impaired or even distorted (e. g. [Better Images of AI, 2024; Guzman, 2017; Kurenkov, 2019; Mustaklem, 2024, quoted from Adami, 2024]). Romele [2022, p. 4] even describes some stock images on the one hand as “unethical”, because they “do not ‘humbly’ represent the ‘things themselves’; they let more than what they are supposed to show be seen (certainly more than what is concretely done in technological innovation in AI)” and on the other hand as “unpolitical”, because of their “incapacity to promote forms of disagreement among concerned groups beyond a simplistic logic of oppositions – goodness/ badness, risk/ opportunity, humans/ nonhumans” [Romele, 2022, p. 4]. To quote a few more concerns:

> Abstract, futuristic or science-fiction-inspired images of AI hinder the understanding of the technology’s already significant societal and environmental impacts. Images relating machine intelligence to human intelligence set unrealistic expectations and misstate the capabilities of AI. Images representing AI as sentient robots mask the accountability of the humans actually developing the technology, and can suggest the presence of robots where there are none. [Better Images of AI, 2024]
>
> … pictures of shiny humanoid robots mislead us as to what AI is, and also reinforce harmful stereotypes [AI Myths, n.d.].

Concerns surrounding clichéd AI visualizations arise because the visual plays a crucial role in the social construction of reality [Lucht, Schmidt & Tuma, 2013]. The considerations are based on a constructivist idea: It is assumed that the way AI is visually represented shapes society’s knowledge and ideas about AI [Berger & Luckmann, 1969; Hepp et al., 2017; Kalwa, 2024, quoted from Metz, 2022]. By directly addressing the human sense of sight, visualizations create a sense of reality. Further, AI images make the invisible (technology) visible. Through this visibility, they construct a – possibly unrealistic – reality [Grittmann & Ammann, 2011; Müller 2003]. Even

further goes Romele [2022, p. 2], who argues that visual as well as written representations of technology "become conditions of possibility for the existence and development of specific technologies", which is why visualizations of AI as an emerging technology matter.

As part of our study, we examine whether the concerns regarding the visualizations of AI are justified respectively have an empirical basis. We are investigating how selected German quality print media visualize and frame articles on AI. Our paper is organized as follows: We commence by examining the significance of visual media representations of artificial intelligence as a compelling subject for investigation. Subsequently, we present an overview of the current state of research and derive our research questions. We then delineate our methodological approach and present the results of our analyses. Finally, our paper concludes with a summary and a discussion of the findings.

Why an Analysis of AI Images in News Media Coverage?

As a matter of fact, images are an integral part of journalistic reporting [Renner, 2013] and generate a high level of attention among the recipients, even more than pure text. They can be processed quickly, are easy to mentally fixate and to remember [Geise, Lobinger & Brandtner, 2015; Geise & Rössler, 2012; Kong, 2019; Müller, 2003]. Above and beyond, images are "powerful framing tools" [Rodriguez & Dimitrova, 2011, p. 50; see also Geise, Lobinger & Brandtner, 2015] – when textual and visual framing are in conflict, visual frames often prevail [Rodriguez & Dimitrova, 2011].

And this is of particular relevance considering the public's knowledge of AI, which is at best "patchy" [Nader et al., 2022, p. 713; see also Adami, 2024], even though AI is anticipated to become increasingly embedded in our daily lives. This is why (media-mediated) images of AI are expected to hold significant potential to affect public perception of AI as well as expectations, fears or hopes about it [Cave et al., 2018; Kong, 2019].

According to Gamson et al. [1992, p. 374], especially images generated through and disseminated by mass media are utilized by the recipients "to construct meaning about political and social issues." This view is also expressed in an article from the Guardian on misleading media coverage of AI: "Why do people believe so much nonsense about AI? The obvious answer is that they are influenced by what they see, hear and read in mainstream media." [Naughton, 2019]. Also Kalwa [2024, quoted from Metz, 2022] states, that when people come into contact with illustrated (journalistic) texts on AI in public debates, this influences how knowledge and ideas about AI are constituted. However, AI visualizations contained in media coverage are also assumed to be "inappropriate" in a way by various actors:

> … if you were writing a news article about apples, you wouldn't put a photo of a pear at the top. But if you're reading a story about large language models, you have a photo of a robot at the top, even though there are no robots anywhere near large language models. I think that it reinforces the opacity and difficulty

> accessing and understanding the technology even for people in the media and for researchers. This is creating a gap in terms of how well we understand the technology. [Mustaklem, 2024, quoted from Adami, 2024].
>
> Even technology that is per definition not robotics (e.g. artificial intelligence or simple software) is routinely referred to as a robot and illustrated with pictures of humanoid robots that have nothing to do with the technology at the center of the article. … artificial intelligence used for research tasks in law firms becomes a 'robot lawyer' and investment software becomes a 'robot adviser' [Meinecke & Voss, 2018, p. 211].

Schmitt [2021] takes this further, asserting that many AI images are not only unrelated to the news article and merely decorative, but even harmful to the public imagination. "They influence how we develop, think of and design policy for emerging technologies". He continues: "Instead of inviting public discourse around urgent questions like bias in machine learning systems …, these images suggest that readers should run from robot overlords or thrust their heads into a blue binary code utopia." [Schmitt, 2021]

State of Research and Research Questions

Despite these concerns, to our knowledge there are no reliable (quantitative) analyses on the topic of AI visualizations in media coverage available so far.

While content analysis is one of the most frequently used methods in communication studies, visual content analysis is a rather "little-studied field of research" [Rössler, 2010] – although visual elements in media coverage have increased significantly since the 19th century [Wilke, 2011; Geise & Rössler, 2012]. Consequently, several researchers complain about the marginality of the image as a central research object [Grittmann & Lobinger, 2011; Schnettler & Bauernschmidt, 2018]. If images are analyzed in content analysis, most studies concentrate on the description of formal elements or the counting of depicted actors often neglecting the deeper content of images and its visual representation [Geise & Rössler, 2012].

With regards to the topic AI, textual communication about generative AI in news media coverage has already been analyzed (e. g. [Brennen, Howard & Kleis-Nielsen, 2018; Ding & Kong, 2019; Kieslich et al., 2022; Obozintsev, 2018; Ouchchy, Coin, Dubljević, 2020; Sun et al., 2020; Vergeer, 2020]) – however, images of AI in news coverage were – if at all – simply recorded as additions. We are only aware of a single conference proceeding that focuses on AI representations in news photographs in the U.S. and China [Kong, 2019]. According to Kong [2019], the analyzed news images paid more attention to humans than to machines. Humans were present in 72 (New York Times) respectively 85 percent (China Daily) of the AI images in the analyzed newspapers. If AI applications were visualized in the images, humanoid robots were the typical form – which, as described in the introduction, can be seen as problematic. In sum, the images analyzed by Kong [2019] conveyed a rather positive attitude towards AI. Meinecke and Voss [2018] in a paper on "Robotics in Science Fiction and Media Discourse" devote a subchapter to robots in media coverage and find that these are

often used to illustrate AI – however, their results do not seem to be based on a systematic content analysis but are illustrated using selected examples.

Beyond that, to our knowledge there are only few studies that analyze (mostly fictional) visual AI narratives in literature and film using qualitative research approaches [e. g. Cave et al., 2018; Hermann, 2023; Xanke & Bärenz, 2012].

Our study seeks to address this gap. We argue, following Pentzold, Brantner and Fölsche [2018, p. 140], that visualizations of AI articles "are an object of analysis in their own right and with an inherent representational logic." We think it is a challenge for journalism to visualize an invisible technology and "to give palpable form to a discrete phenomenon" [Pentzold, Brantner & Fölsche, 2018, p. 140].

Based on the discussion about the potentially problematic visualizations of AI, the overarching research questions of our analysis are: How do German print media visualize articles on AI? Do the selected images of AI in news coverage appear appropriate in terms of content for the AI being discussed? And can recurring visual frames be recognized in the medial, visual representation of AI? Specifically, we aim to investigate the following research questions:

> RQ1. How often are articles on artificial intelligence illustrated in selected German print media?
>
> RQ2. Which visualization types are predominantly used in German print media coverage?
>
> RQ3. What can be seen in the images (pictorial objects) attached to German print media articles on AI?
>
> RQ4. Do the pictorial objects match the respective AI that is the subject of the news article?
>
> RQ5. Can different visual frames be identified in German news media coverage about AI?

We will answer all of these questions by comparing them over time, as we are analyzing two investigation periods (2019 and 2022/2023).

Theoretically, our analysis connects to the visual framing theory. Despite an increasing number of framing studies, framing has primarily been analyzed with a focus on textual media messages [Geise, Lobinger & Brandtner, 2015]. The "question of how issues are framed through images that stand alone or accompany text has remained relatively under-researched" [Rodriguez & Dimitrova, 2011, p. 49].

Visual framing is understood as a specific dimension of framing and defined as

> the process and/or the result of selecting and accentuating certain aspects of perceived reality in a communicative context by means of visual communication, through which specific structuring and interpretation patterns and/or

> recommendations for action for the described facts are suggested and which shape information processing[1]. [Geise, Lobinger & Brandtner, 2015, p. 46]

Applied to the research subject of visualizations of articles on AI, we analyze the result of the journalistic selection of specific images to visualize the AI topic in news media coverage, which can imply a certain meaning or interpretation to the recipient [Geise & Lobinger, 2015; Müller, 2011; Schwalbe, 2006]. The way in which picture editors illustrate articles can give recipients a specific direction of interpretation by telling people not only what to think about the communicated message, but also *how to think about it* [Geise & Rössler, 2012]. Through our analysis, we want to find out whether certain visualizations of AI dominate German media coverage and whether they could evoke a certain idea of AI that may be inappropriate regarding the AI application addressed[2].

Method

To answer our research questions and to analyze how articles on AI are visualized in news media coverage, our study uses a mixed-methods design. We conducted a qualitative as well as a quantitative visual content analysis (according to [Grittmann & Lobinger, 2011]) of illustrated German national print media articles on AI. Our analyses focus on two time periods: on the one hand the time period between January 1 and December 31, 2019 has been analyzed and on the other hand the time period between November 1, 2022 and October 31, 2023. We chose 2019 as period of analysis because it was named the "Science Year of Artificial Intelligence" by the German Federal Ministry of Education and Research [BMBF, 2021]. It can therefore be assumed that the topic of AI was considerably covered during this year. The time period between November 2022 and October 2023 was chosen as it covers one year after the introduction of ChatGPT in Germany, which was in November 2022.

As news media titles, we chose six (leading) national quality newspapers and news magazines in Germany, representing the political spectrum from "left" to "right" (Scheufele & Engelmann, 2013), namely: Süddeutsche Zeitung (SZ), Frankfurter Allgemeine Zeitung (FAZ), Die Welt (DW), taz, Der Spiegel, and Die Zeit. All illustrated articles during the analysis period that contained the keywords "artificial intelligence" or "AI"[3] in their headline or subtitle were selected for analysis (to preferably analyze only those articles that deal with AI as a main topic). Our search resulted in 589

---

[1] Translation of the original German quote: "Visuelles Framing ist der Prozess und/oder das Ergebnis der Selektion und Akzentuierung bestimmter Aspekte der wahrgenommenen Realität in einem kommunikativen Kontext durch Mittel Visueller Kommunikation, durch die spezifische Strukturierungs- und Interpretationsmuster und/oder Handlungsempfehlungen für den beschriebenen Sachverhalt nahegelegt werden und die die Informationsverarbeitung prägen." [Geise, Lobinger & Brandtner, 2015, p. 46]

[2] However, since our study is a pure content analysis, we cannot make any statements about actual effects. Yet, there are analyzes that show how media framing of AI can influence recipients' understanding of AI (e. g. [Obozintsev, 2018].

[3] German search string: "Künstliche* Intelligenz OR *KI*"

illustrated articles with n = 818 images in total (some articles contained more than one image).

Following Geise and Rössler [2012], we distinguished between several dimensions of image analysis: On the *presentation level*, we manually coded formal features like medium, date, department and visualization type of the image. On the *object level*, we coded the visual objects with different levels of detail. Per image, several image objects (like human, robot, computer etc.) with multiple specifying subcategories could be coded, for example if an image shows a human and a robot at the same time. On the *tendency* and on the *meaning level*, we coded the main AI subject covered in the article (using inductive coding of the article headlines, subtitles and text), and framing elements.

Regarding the identification of frames, we used a mixture of an interpretative-quantifying method and a cluster-method [Matthes & Kohring, 2004]. Therefore, the frames were initially generated qualitatively and interpretatively from the 2019 material by following the qualitative iconographic-iconological approach [Panofsky, 1979; see also Grittmann & Ammann, 2011; Geise & Rössler, 2012]. This methodological three-step approach can be used for the systematic interpretation of images and does not bring out the forms or motifs of an image, but rather its central pictorial content. Firstly, we coded the so-called *pre-iconography*, the “primary subject” of the image. It focuses on existing semiotic image objects, such as persons, non-human objects or actions (what is depicted?). The goal is an objective description of the existing image objects including individual everyday theoretical experiences [Müller, 2003]. Secondly, we noted the *iconography*, the “secondary subject”, reconstructing the thematic embedding of the image. The previously analyzed “what” is expanded and contextualized by including information from the title and subtitle, image headline and caption. Thirdly, the iconographic analysis was expanded by deriving the actual meaning and central image statement in an interpretative act, which we summarized (so-called *iconology*) [Panofsky, 1975]. This three-step resulted in six qualitatively identified AI frames:

- *Potential uses of AI*: Visualization of potential or real uses of AI in all areas of life with dominant positive connotations.
- *Danger potential*: Visualization of dangers that may arise from widespread hasty or non-critically reflected deployment of AI applications.
- *Competition*: Visualization of existing national and international competition in AI development, research and implementation.
- *Human role model*: Visualizations that show humans as an ideal role model for hard- and software, whose control is based on AI.
- *(Further) development*: Visualizations that focus on previous developments in the field of AI but also developmental work, which is still ongoing.
- *Cultural and artistic debate*: Visualizations that show the cultural or artistic engagement with AI as a technology.

From these qualitative frames, binary categories were derived for the quantitative content analysis as frame elements (e. g. Are chances or opportunities associated with AI discussed? Are risks or dangers associated with AI discussed? etc.), which were coded within the AI image in combination with the article headline, teaser and subtitle[4] for both study periods (2019 as well as 2022/23). Using hierarchical cluster analysis, they were subsequently assembled into frames, so that quantitatively we did not code the complete frame directly, but individual frame elements [Matthes & Kohring, 2004] to improve the reliability of coding.

A team of three coders was assembled to carry out the quantitative content analysis. The coders underwent multiple training sessions and were provided with a detailed coding manual to ensure a consistent understanding of the classification scheme. The complete codebook for our analysis is attached as an appendix.

The intercoder reliability values (three coders) for formal features and pictorial objects ranged between 0.74-1 (Krippendorff's alpha) and for AI subject and frame elements 0.64-0.95 (Krippendorff's alpha).

Results

Amount of visualized AI news coverage

Regarding our first research question, our data show that within our analyzed news media sample in 2019, n = 125 visualized articles (containing at least one article image) on the main topic of AI were published, while in the second year of analysis it were n = 464 articles. Thus, the quantity of visualized AI articles significantly increased in 2022/23. This finding indicates the increased social relevance of the AI issue, which is why journalism reports on it more frequently – and apparently also visualizes the subject more often. The number of images within these news articles on AI has more than quadrupled (from 150 images in 2019 to 668 images in 2022/23; see Figure 1). On average, in 2019 each visualized article on AI contained 1.2 images. In 2022/23, it was 1.44 images per article.

[4] In this respect, the interplay of image and text was captured here as binary frame elements – viewing the AI-images alone did not allow sufficient coding of the frame elements.

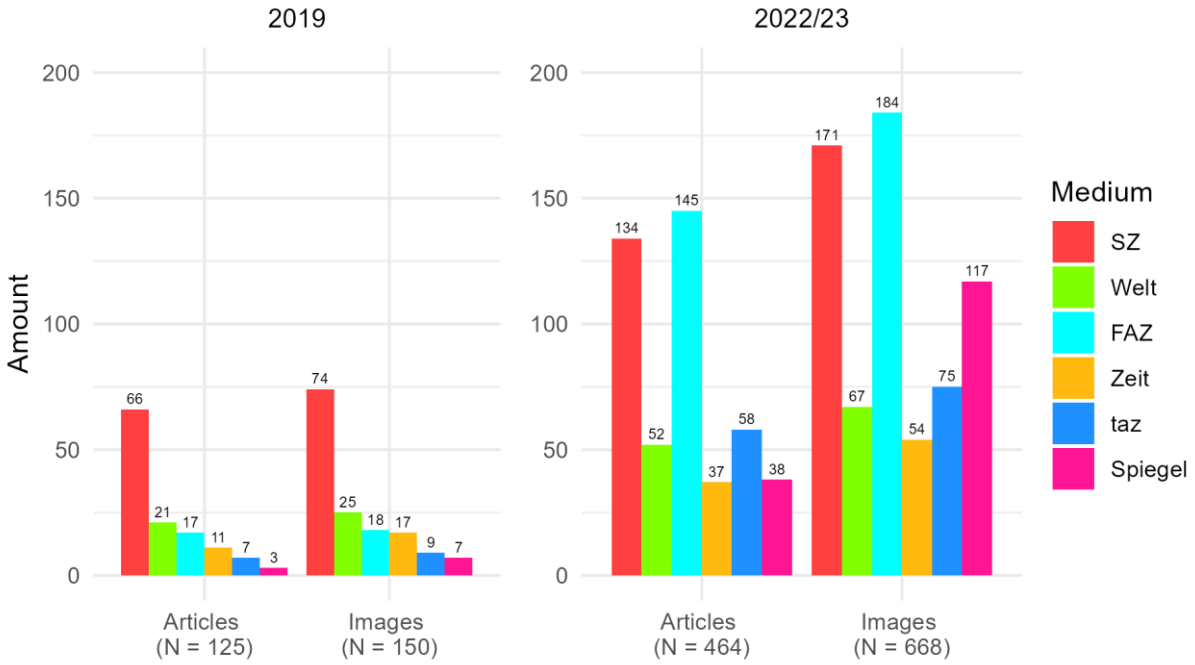

Figure 1: Visualized AI articles and AI images in German print media coverage (in %)

By far the most news articles and images of AI were published by the Süddeutsche Zeitung (in sum: n = 200 articles and n = 245 images). Regarding the number of images, the SZ is followed by the FAZ (n = 202), which also contributes the second most articles (n = 162) on the topic, and Der Spiegel (n = 124) – although it only appears weekly. Both significantly increased their number of visualizations in the second period of analysis.

As shown in Figure 2, most often the AI articles and images were published in the economics department (34% in 2019 vs. 36% in 2022/23), followed by the feuilleton (18% vs. 19%) and science department (14% vs. 12%).[5] These results indicate that AI in German print media coverage is predominantly discussed as an economic phenomenon or as a phenomenon with economic consequences (one third of the visualized articles).

[5] Category “other” includes the first sections of the newspapers, discussion segments and special issues or supplements, for example.

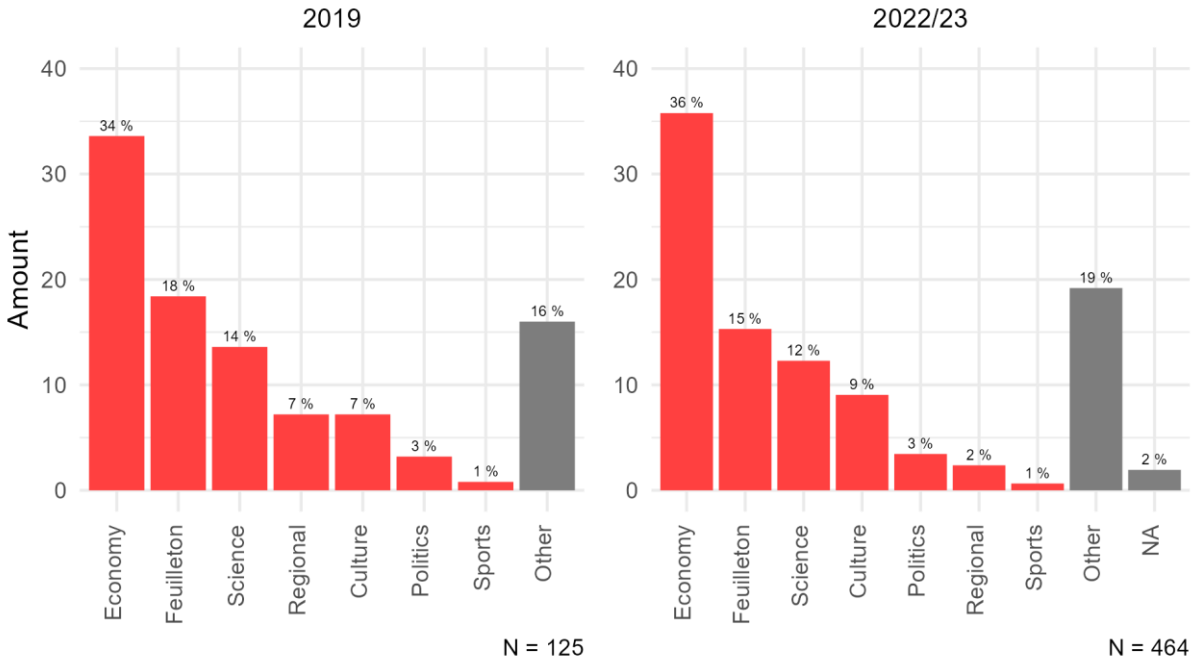

Figure 2: Visualized AI articles per department (in %)

Visualization types in AI news coverage

Regarding the visualization types (RQ2), in 2019, the vast majority of AI images, namely two thirds, were photographs, with illustrations (visualizations drawn by hand or digitally) being the second most common visualization type (see Figure 3). Together, these two visualization types make up 86 percent of all AI images in German news media coverage. In 2022/23, the dominance of these two visualization types decreased (74%) and overall, the types of visualization became more diverse. This is particularly true for the taz, Der Spiegel and Die Zeit.

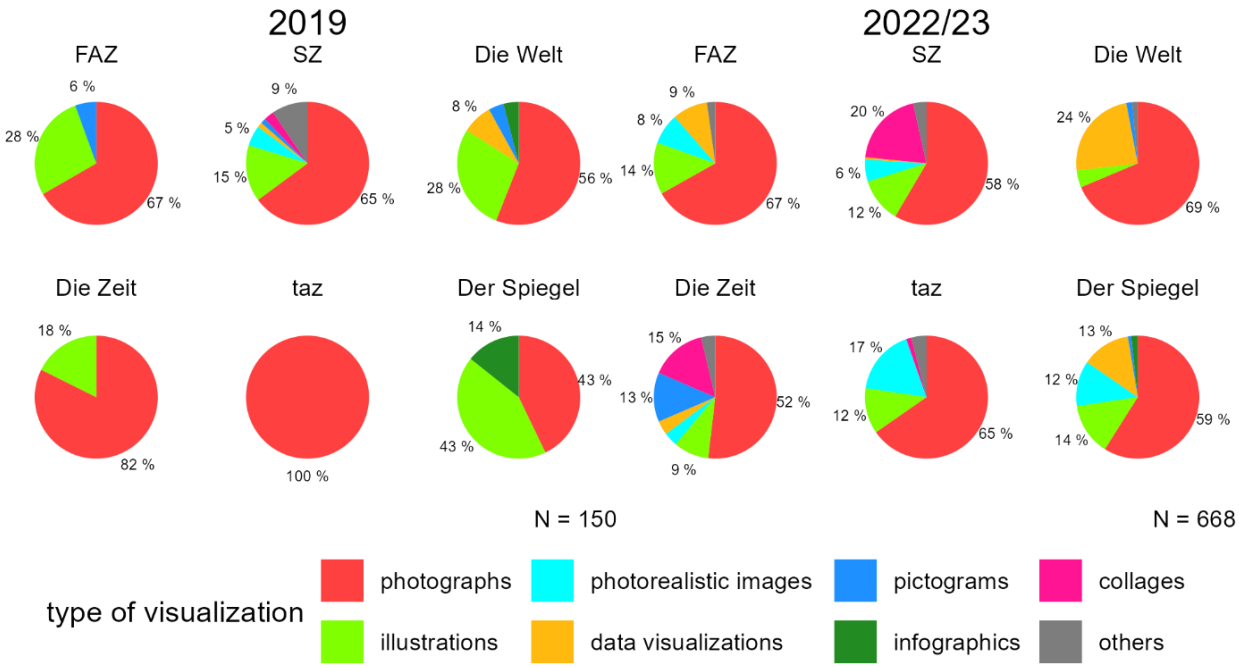

Figure 3: Visualization types of AI images in German print media coverage (in %)

In detail, there are a few differences in the preferences of the individual media with regard to visualization types. Der Spiegel, which used illustrations very frequently in 2019, has greatly reduced this type of visualization, but in 2022/23, together with FAZ and Die Welt, it is one of the most frequent user of data visualizations (such as diagrams, statistical graphics). SZ and Die Zeit, on the other hand, apply collages (consisting of several individual images that are combined to form an image) most often of the print media we analyzed to visualize AI. Pictograms (simple, graphic symbols that convey information, such as on street signs or public toilets) are only used to a significant extent in Die Zeit.

Pictorial objects in AI news coverage

Regarding the question what actually can be seen in the AI images (RQ3), we coded n = 219 pictorial objects within the 150 images from 2019 and n = 1009 pictorial objects within the 668 images from 2022/23. Our data shows that interestingly AI was most often illustrated by pictures of humans, not visualizing the AI itself, but usually the protagonists of the article (44% in 2019; 45% in 2022/23; see also Kong, 2019), followed by robots (16% in 2019; 7% in 2022/23) or computers (9% in 2019; 13% in 2022/23) (see Figure 4).

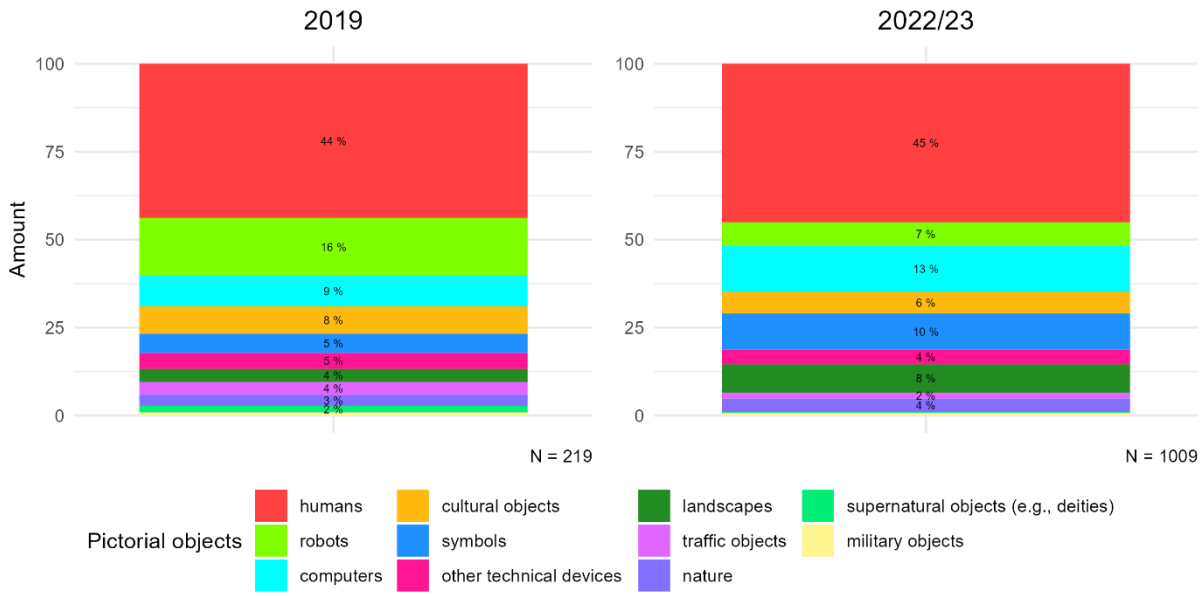

Figure 4: Pictorial objects of the visualizations (in %)

In all newspapers respectively news magazines except for Die Zeit, the proportion of robot images declined and the relationship between AI visualized as robots compared to AI pictured as computer object changed in favor of the computer depictions. This is especially apparent in the SZ (15% robots and 7% computers in 2019 vs. 9% robots and 17% computers in 2022/23). The biggest amount of computer objects accompanying AI articles can be found across both years in Die Zeit (15% in 2019; 19% in 2022/23), which consequently comes along with a smaller share of pictures containing robots (10% in 2019; 4% in 2022/23). Further, it seems worth mentioning that the two newspapers that seldom picture robots in the later period – namely Die Welt and Der Spiegel (both 3%) – use symbolic objects significantly more often than other sources (20% for Die Welt; 16% for Der Spiegel, compared to 10% or lower in Die Zeit, SZ, and taz).

Diving into more detail, the human subjects pictured were most often persons for whom we could capture different characteristics like gender and profession. Looking at this, we found slightly more male people in both investigation periods (50% in 2019; 62% in 2022/23), but as the difference between male and female actors appears rather small, one cannot assume a male dominance or male-bias (as presumed by [Jeong Gu, 2020 or Roesler, Heuring & Onnasch, 2023], for example) in the visualizations of articles on AI. Regarding the professions, we identified scientists (19% in 2019; 21% in 2022/23) and managers as well as people associated with culture, e. g. musicians and artists (18-20%) as the most common visualized professions. For the interpretation of these results, one has to take into account that most of the visualizations that contained humans were picturing the human protagonists of the article (45% in 2019; 54% in 2022/23), followed by visualizations that tried to capture AI directly (37% vs. 23%). Surprisingly, robots played a less important role in visualizing AI in the later period. Out of 1009 pictorial objects only n = 67 robots were identified (7%), which can nearly exclusively be described as humanoid cyborgs (97%). This dominance of human-like

androids in images that contain robots is observable in both periods, but the variety of these depictions decreased over time (80% humanoid cyborgs in 2019). The decline in robot images may be explained by different AI subjects reported in 2022/23 compared to 2019. It might be possible that due to new contacts with AI technologies, following the publication of ChatGPT and other tools based on Large Language Models (LLMs), journalist's imagination of what AI is and how it looks like shifted from picturing AI as human-like, autonomous robots to seeing it as a "simple" computer program that can be used in everyday life.

Supporting this assumption, the proportion of illustrated articles that mentioned at least one type of generative AI has almost quintupled from 2019 to 2022/23 (11% in 2019 compared to 54% in 2022/23) in particular by addressing Large Language Models (69%) (see Figure 5). ChatGPT accounts for the largest share of LLMs, as it captures nearly a quarter of the n = 833 addressed AI specifications within the visualized articles in 2022/23 (66% of LLM-centered articles), whereas other Large Language Models such as Google Bard (7% of LLM-centered articles) or Meta's LLaMa (2% of LLM-centered articles) were seldomly mentioned in articles about AI. This is also reflected in the pictorial objects in 2022/23, where ChatGPT is the most visualized computer element alongside computer chips (both 19%).

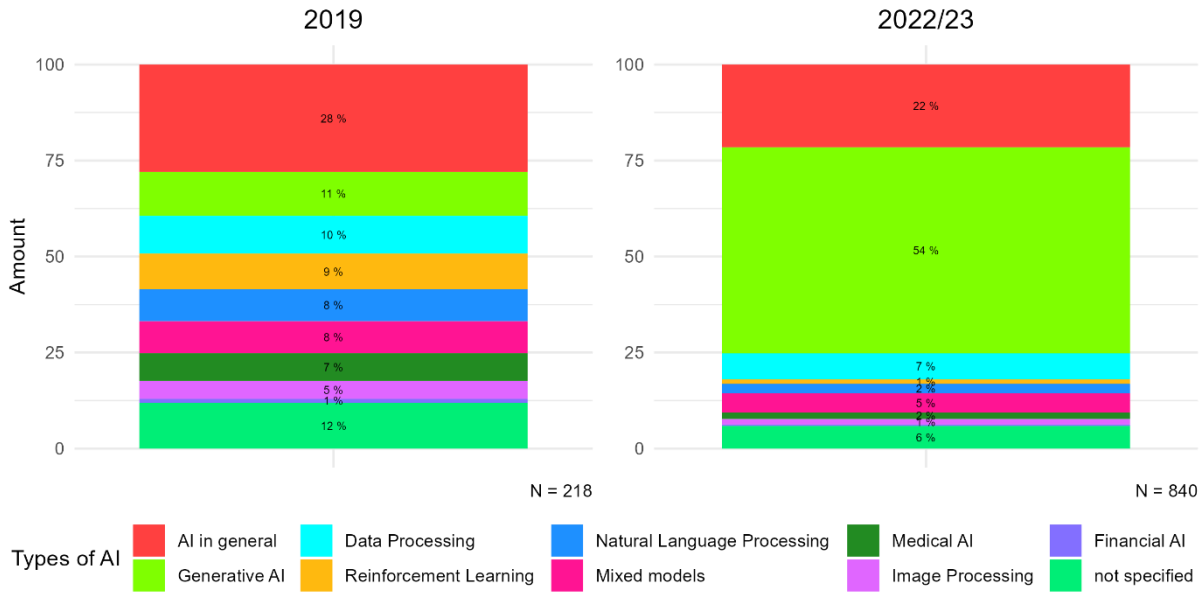

Figure 5: Types of AI mentioned in German news media coverage on AI (in %)

Image-to-text gaps within AI news coverage

Addressing the critique that news media articles often depict AI in a clichéd and inappropriate manner – primarily through the portrayal of humanoid robots or cyborgs – we must first clarify that the perceived predominance of these figures is not evident in the German news media coverage we analyzed, as only 7% of the pictorial objects are robots. Instead, human figures constitute the predominant visual objects across all articles discussing any form of AI (44% of images in 2019 and 45% in 2022/23).

Second, since these human representations typically depict the protagonists of the articles, we cannot assert the existence of an image-to-text gap in these instances.

With regard to our fourth research question if the pictorial objects match the respective AI that is the subject of the news article, the second most frequently identified pictorial object in 2022/23 were computer components (15%). They are used most often to visualize articles that thematically deal with Natural Language Processing and Image Processing in both time periods (see Tables 1 and 2), which seems appropriate in the broadest sense. Thus, we cannot speak of a striking image-to-text gap here either.

In terms of robot images, which are particularly criticized as being inappropriately chosen to visualize certain AI types, we can state that if robot images occur, then they most often illustrate articles that revolve around reinforcement learning (in 2022/23 and 2019), medical AI and image processing (both in 2019) (see Tables 1 and Table 2). Reinforcement learning can be described “as a branch of Machine Learning where an intelligent agent takes decisions in an environment to maximize a cumulative reward” [Eßer, 2023]. This method is often applied to the domain of robotics, which is why a visualization of articles on this type of AI through robot images seems largely suitable. In the case of image processing, visualizations through robot images seem appropriate if the technology is used to help robots to navigate, identify and locate objects, identify faces or similar. In the case of medical AI images of robots only seem appropriate if robot assistants in the OR are addressed, which was only the case in two articles from 2019. Apart from that, robot images are often used as symbols for AI in general when no specific AI is addressed in the news articles (however, less often in 2022/23 compared to 2019). Articles on generative AI (GenAI) models (e. g. Large Language Models like ChatGPT or image generating AI like Dall-E) are relatively seldom visualized with robot images (8% of GenAI-articles in 2022/23). Accordingly, we would conclude that our analysis could not reveal the often-presumed divergence between textual and visual AI coverage, especially with regards to robot images.

	Types of AI	human	supernatural	robot	computer	technical device	nature	symbol	culture	landscape	traffic	military
0	AI in general (N = 54)	62.96	0.00	18.52	1.85	0.00	1.85	1.85	12.96	0.00	0.00	0.00
1	Generative AI (N = 22)	68.18	0.00	4.55	0.00	0.00	4.55	0.00	18.18	4.55	0.00	0.00
2	Image Processing (N = 9)	33.33	0.00	22.22	33.33	0.00	0.00	0.00	11.11	0.00	0.00	0.00
3	Natural Language Processing (N = 16)	43.75	0.00	18.75	0.00	0.00	0.00	6.25	6.25	18.75	6.25	0.00
4	Reinforcement Learning (N = 18)	33.33	0.00	27.78	0.00	5.56	0.00	5.56	11.11	0.00	16.67	0.00
5	Data Processing (N = 19)	57.89	0.00	21.05	0.00	0.00	5.26	0.00	0.00	10.53	5.26	0.00
7	Medical AI (N = 14)	64.29	0.00	28.57	0.00	0.00	0.00	7.14	0.00	0.00	0.00	0.00
8	Financial AI (N = 2)	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	not specified (N = 23)	82.61	0.00	13.04	0.00	0.00	0.00	4.35	0.00	0.00	0.00	0.00
10	Mixed models (N = 16)	50.00	6.25	12.50	0.00	0.00	0.00	0.00	0.00	6.25	18.75	6.25

N = 193

Table 1: Pictorial objects assigned to types of AI in German news media coverage on AI in 2019 (in %)

	Types of AI	human	supernatural	robot	computer	technical device	nature	symbol	culture	landscape	traffic	military
0	AI in general (N = 179)	64.25	0.00	11.17	6.70	0.56	2.23	8.94	2.79	2.79	0.56	0.00
1	Generative AI (N = 446)	60.54	0.22	8.30	9.19	1.12	2.24	7.85	4.26	5.16	1.12	0.00
2	Image Processing (N = 12)	50.00	0.00	0.00	16.67	0.00	8.33	16.67	0.00	8.33	0.00	0.00
3	Natural Language Processing (N = 20)	30.00	5.00	10.00	20.00	0.00	5.00	10.00	15.00	5.00	0.00	0.00
4	Reinforcement Learning (N = 10)	40.00	0.00	30.00	0.00	0.00	0.00	20.00	10.00	0.00	0.00	0.00
5	Data Processing (N = 56)	51.79	0.00	7.14	7.14	5.36	8.93	12.50	5.36	0.00	0.00	1.79
7	Medical AI (N = 14)	92.86	0.00	0.00	0.00	0.00	7.14	0.00	0.00	0.00	0.00	0.00
8	Financial AI (N = 3)	66.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00
9	not specified (N = 49)	51.02	0.00	4.08	16.33	0.00	2.04	18.37	4.08	4.08	0.00	0.00
10	Mixed models (N = 42)	66.67	0.00	9.52	0.00	2.38	0.00	4.76	7.14	7.14	2.38	0.00

N = 831

Table 2: Pictorial objects assigned to types of AI in German news media coverage on AI in 2022/23 (in %)

Visual frames in AI news coverage

In conclusion, to address our fifth research question, we conducted a hierarchical cluster analysis of the six coded frame elements (chances, risks, competition, cultural debate, development, human role model). Utilizing the Ward method and squared Euclidean distance, we grouped AI images into clusters that minimized intra-group variance while maximizing inter-group differences. This analysis yielded a total of five visual frames in AI news coverage for 2019 (see Figure 6) and seven frames for 2022/23 (see Figure 7).

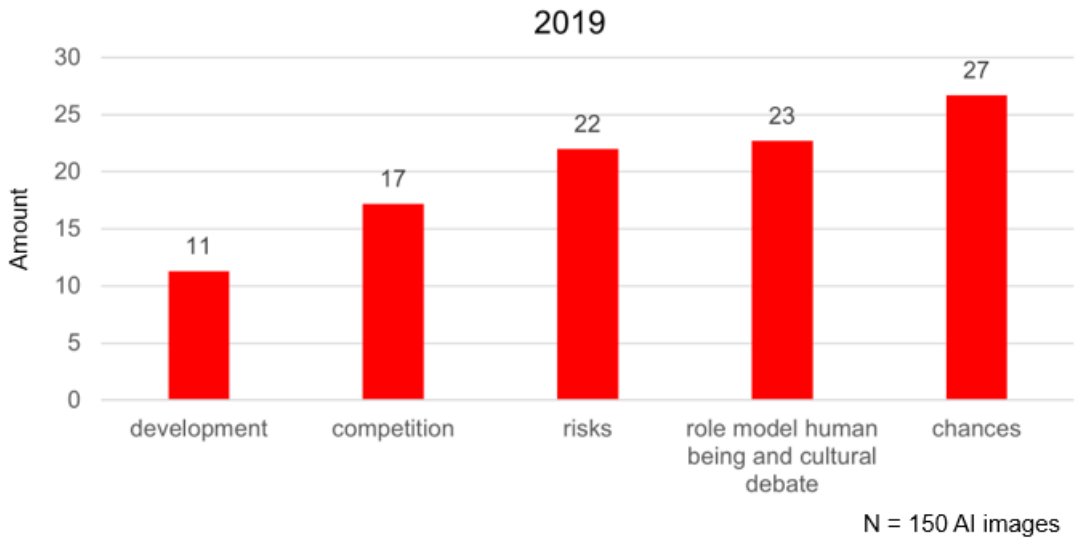

Figure 6: Frames of AI visualizations in German news media coverage on AI in 2019 (occurrence of frames in %)

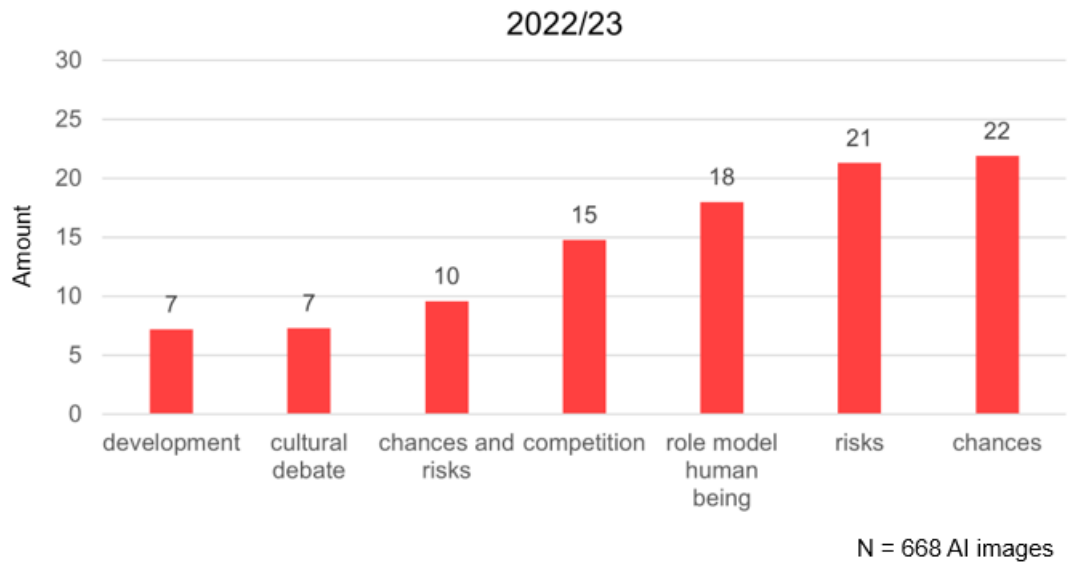

Figure 7: Frames of AI visualizations in German news media coverage on AI in 2022/23 (occurrence of frames in %)

The cluster or frame in 2019 and in 2022/23 to which most AI images belong is the "chances frame", where images in combination with textual elements of the article address positive or uncritical social aspects of a specific application of AI as opportunities or advantages for society or social actors. Over time, however, we see a decrease in this frame (from 27% to 22%), whereas the so-called "risk frame" (where images and textual elements address the social risks of the widespread, hasty or unthoughtful use of AI applications or solution strategies to address these dangers) remains relatively stable (22% respectively 21%). In 2022/23, however, the frames have become somewhat more differentiated. On the one hand, a new "mixed evaluations frame", which weighs both chances and risks equally (10%), has emerged. Further, the formerly combined frame elements "cultural debate"[6] and "role model human being"[7] have become two separate frames in 2022/23. Thus, the framing of AI visualizations becomes more differentiated over time. Small decreases can be observed in the "competition frame" (from 17% to 15%), which addresses national or international competition in AI development, research and implementation, and in the "development frame" (from 11% to 7%), which focuses on the technical/ scientific aspects of producing new AI applications or further developing existing models.

Looking at which newspapers use which frames most frequently within their AI coverage, it is noticeable that in 2019 the chances frame was used proportionally most frequently within the taz (44% of the frames within taz) and Die Welt (36%), whereas in 2022/23 it was Die Zeit (32%). The risk frame was dominant in AI visualizations of Der Spiegel (2019 as well as 2022/23; 57% respectively 25% of the frames within Der

[6] Which is about taking up social discourses in the art and culture sector and describe an artistic examination of the topic of AI, e. g. exhibitions on the topic, theater performances about AI etc.
[7] Which brings the imitation respectively simulation of human characteristics through AI systems to the fore, also weighing up chances and risks as associated frame elements.

Spiegel) and Die Zeit in 2019 (41% of the frames within Die Zeit). It is remarkable that Die Zeit has changed their framing of AI visualization from a dominant risk to a dominant chances frame. The competition frame was used above average by the FAZ in 2019 (44% of the frames within FAZ) and by Die Welt and FAZ in 2022/23 (22% within Die Welt and 20% in FAZ); it was not used at all by Der Spiegel in 2019, which, however, used this frame in 18% of its AI visualizations in 2022/23. Beyond this, in 2019 the frame “role model human being and cultural debate” was not used at all by Der Spiegel. The taz did not use the development frame in 2019. However, both news media titles took up these frames in 2022/23, with the taz being the medium which within its coverage uses the “role model human being” frame most often in 2022/23.

Summary and discussion

Returning to the question posed in our paper's title, we can provide a clear answer: Yes, German print media articles on AI feature a greater variety of visual elements beyond just humanoid robots and cyborgs. In both periods of analysis, humans were the most often visualized pictorial objects (as many visualizations focused on protagonists of the articles), in the second analysis period robots even played a less important role in visualizing AI than in 2019, while computers became more prominent. This development could – according to Better Images of AI [2024], Mustaklem [2024, quoted from Adami, 2024] or Moretti and Rogers [2022], for example – be interpreted as positive. Regarding the often-presumed inappropriate visualizations of AI in news media coverage, on the whole our analysis did not reveal striking or pronounced image-to-text gaps. Most robot images were used in robotic topic contexts, whereas for example articles on generative AI models were seldomly visualized with robot images. Further, our analysis showed a boost in AI coverage and AI article visualizations in the latest years (especially in SZ, FAZ and Der Spiegel). This indicates that the topic has increased in public and societal significance over time, particularly following the introduction of ChatGPT in Germany. Economy and feuilleton are the news media departments in which articles and visualizations of AI were most frequently published. This indicates that the topic AI was frequently discussed as a phenomenon with economic consequences in German news media coverage. Between 2019 and 2022/23, the types of visualizations in AI news coverage became more diverse; collages, pictograms, and data visualizations came in and replaced some of the predominantly used photographs. With respect to the identified visual frames, German news media coverage has increasingly weighed the opportunities and risks over time. Overall, this indicates a relatively nuanced journalistic reporting.

On the basis of our study, we cannot say anything about the topic of AI generated images, because we did not analyze this kind of AI visualizations separately, even though we coded some of them accompanying articles referring to generative AI technologies like MidJourney. However, AI-generated images could be also chosen by news actors to visualize topics that aren’t related to AI, which could be an interesting topic for future research.

Further, through this analysis we cannot offer journalists a real "solution" to the problem of visualizing an invisible technology. But we recommend that journalists should, as they already tend to do especially in the later period, pay attention to a connection between AI visualization and content (for example, not using robots to illustrate LLMs). This presupposes of course that journalists in fact really want to visualize AI (more often), and the currently common identified depiction of other objects like human protagonists is seen as a strategy to avoid the problem of visualizing invisible technologies. To assess that, it would be interesting to investigate the journalist's intents and motivations in terms of selecting fitting pictures for their AI articles.

In an editorial on a platform dedicated to informed coverage of AI trends and news, Kurenkov [2019] outlines a list of best practices for news media coverage of AI. This initiative aligns with the work of Better Images of AI [2024], which has since developed a comprehensive guide for the creation and utilization of AI images [Dihal & Duarte, 2023] and offers a detailed list of dos and don'ts for enhancing the visualization of AI. Among the recommended practices is the portrayal of realistic applications of AI, as opposed to science-fiction scenarios. Conversely, one of the cautions emphasizes that journalists should refrain from depicting physical robotic components to visualize AI when such representations do not exist in reality. This raises a critical question: Where can journalists' source suitable images that accurately represent AI? At the very least, Better Images of AI [2024] offers a new repository of AI images created by artists and licensed under various Creative Commons provisions, thereby ensuring easy accessibility. However, whether these images are genuinely "better" than those currently utilized in news media coverage warrants further discussion.

References

Adami, M. (2024, April 23). *What's wrong with the robots? An Oxford researcher explains how we can better illustrate AI news stories*. Reuters Institute for the Study of Journalism. Reuters Institute. Retrieved from https://reutersinstitute.politics.ox.ac.uk/news/whats-wrong-robots-oxford-researcher-explains-how-we-can-better-illustrate-ai-news-stories

AI Myths (n.d.). *AI = shiny humanoid robots*. AI Myths- Retrieved from https://www.aimyths.org/ai-equals-shiny-humanoid-robots#how-can-we-stop-the-terrible-and-inappropriate-robots

Better Images of AI (2024). *Have you noticed that news stories and marketing material about Artificial Intelligence are typically illustrated with clichéd and misleading images?* Better Images of AI. Retrieved from https://betterimagesofai.org/

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. London: Penguin

BMBF (2021). *Wissenschaftsjahr 2019*. Retrieved from https://www.wissenschaftsjahr.de/2019/indexb6b3.html?id=657

Brennen, J. S., Howard, P. N., & Kleis-Nielsen, R. (2018). *An Industry-Led Debate: How UK Media Cover Artificial Intelligence* [Fact Sheet]. Reuters Institute for the Study of Journalism. https://doi.org/10.60625/risj-v219-d676

Cave, S., Craig, C., Dihal, K., Dillon, S., Montgomery, J., Singler, B., & Taylor, L. (2018). Portrayals and perceptions of AI and why they matter. *Apollo-University of Cambridge Repository*. https://royalsociety.org/-/media/policy/projects/ai-narratives/AI-narratives-workshop-findings.pdf

Dihal, K., & Duarte, T. (2023). Better Images of AI: A Guide for Users and Creators. Cambridge and London: The Leverhulme Centre for the Future of Intelligence and We and AI. https://blog.betterimagesofai.org/wp-content/uploads/2023/02/Better-Images-of-AI-Guide-Feb-23.pdf

Ding, H., & Kong, Y. (2019). Constructing Artificial Intelligence in the U.S. and China: A cross-cultural, corpus-assisted study. *China Media Research*, 15(1), 93-105. https://doi.org/10.1145/3233756.3233939

Eßer, J. (2023, July 5). Introduction to Reinforcement Learning – A Robotics Perspective. LAMARR Institute for Machine Learning and Artificial Intelligence. Retrieved from https://lamarr-institute.org/blog/reinforcement-learning-and-robotics/

Gamson, W. A., Croteau, D., Hoynes, W., & Sasson, T. (1992). Media images and the social construction of reality. Annual Review of Sociology, 18, 373-393.

Geise, S., Lobinger, K., & Brandtner, C. (2015). Fractured Paradigm? Theorien, Konzepte und Methoden der Visuellen Framingforschung: Ergebnisse einer systematischen Literaturschau. In Geise, S., & Lobinger, K. (Eds.), *Visual Framing. Perspektiven und Herausforderungen der Visuellen Kommunikationsforschung* (pp. 41-75). Köln: Halem.

Geise, S., & Lobinger, K. (2015). Zur Einleitung: Visual Framing als zentrales Forschungsfeld der Visuellen Kommunikationsforschung. In Geise, S., & Lobinger, K. (Eds.), *Visual Framing. Perspektiven und Herausforderungen der Visuellen Kommunikationsforschung* (pp. 9-18). Köln: Halem.

Geise, S., & Rössler, P. (2012). Visuelle Inhaltsanalyse: ein Vorschlag zur theoretischen Dimensionierung der Erfassung von Bildinhalten. *Medien & Kommunikationswissenschaft*, 60(3), 341-451.

Grittmann, E., & Ammann, I. (2011). Quantitative Bildtypenanalyse. In Petersen, T., & Schwender, C. (Eds.), *Die Entschlüsselung der Bilder: Methoden zur Erforschung visueller Kommunikation: ein Handbuch* (pp. 163-178). Köln: Halem.

Grittmann, E., & Lobinger, K. (2011). Quantitative Bildinhaltsanalyse. In Petersen, T., & Schwender, C. (Eds.), *Die Entschlüsselung der Bilder: Methoden zur Erforschung visueller Kommunikation: ein Handbuch* (pp. 147-162). Köln: Halem.

Hepp, A., Loosen, W., Hasebrink, U., & Reichertz, J. (2017). Konstruktivismus in der Kommunikationswissenschaft. Über die Notwendigkeit einer (erneuten) Debatte. *Medien & Kommunikationswissenschaft*, 65(2), 181-206. https://doi.org/10.5771/1615-634X-2017-2-181

Hermann, I. (2023). Artificial intelligence in fiction: between narratives and metaphors. *AI & Society*, 38, 319-329.

Jeong Gu, Yeon (2020). The Disembodiment of Digital Subjects and the Disappearance of Women in the Representations of Cyborg, Artificial Intelligence, and Posthuman. *Asian Woman*, 36(4), 23-44. https://doi.org/10.14431/aw.2020.12.36.4.23

Kieslich, K., Došenović, P., & Marcinkowski, F. (2022). *Everything, but hardly any science fiction. A topic analysis of German media coverage of AI.* https://www.researchgate.net/publication/365033703_Everything_but_hardly_any_science_fiction

Kong, Y. (2019). Artificial Intelligence in News Photographs: A Cross-Cultural Visual Content Analysis. *Proceedings of the 37th ACM International Conference on the Design of Communication*, Article Number 48, 1-3. https://doi.org/10.1145/3328020.3353905

Kurenkov, A. (2019, November 11). *AI Coverage Best Practices, According to AI Researchers*. Skynet Today. Putting AI News in Perspective. Retrieved from https://www.skynettoday.com/editorials/ai-coverage-best-practices

Lucht, P., Schmidt, L.-M., & Tuma, R. (Eds.) (2013). Visuelles Wissen und Bilder des Sozialen: aktuelle Entwicklungen in der Soziologie des Visuellen. Wiesbaden: VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-19204-8

Matthes, J., & Kohring, M. (2004). Die empirische Erfassung von Medien-Frames. *Medien & Kommunikationswissenschaft*, 52(1), 56-75. https://doi.org/10.5771/1615-634x-2004-1-56

Meinecke, L., & Voss, L. (2018). 'I Robot, You Unemployed': Science-Fiction and Robotics in the Media. In J. Engelschalt, A. Maibaum, F. Engels, & J. Odenwald (Eds.), Schafft Wissen: Gemeinsames und geteiltes Wissen in Wissenschaft und Technik: Proceedings der 2. Tagung des Nachwuchsnetzwerks "INSIST." (pp. 147-162). https://www.ssoar.info/ssoar/handle/document/58220

Metz (2022, April 26). *Humanoide Roboter und Dystopien: Bilder von KI*. Wissenschaftskommunikation.de. Retrieved from https://www.wissenschaftskommunikation.de/humanoide-roboter-und-dystopien-bilder-von-ki-57167/

Moretti, L. T., & Rogers, A. (2022, February 21). *Is Seeing Believing?* [Video]. YouTube. Retrieved from https://www.youtube.com/watch?v=dB-3L-6W_gg

Müller, M. (2003). *Grundlagen der visuellen Kommunikation*. Konstanz: UVK.

Müller, M. (2011). Ikonographie und Ikonologie, visuelle Kontextanalyse, visuelles Framing. In T. Petersen, & C. Schwender (Eds.), Die Entschlüsselung der Bilder: Methoden zur Erforschung visueller Kommunikation: ein Handbuch (pp. 28-55). Köln: Herbert von Halem Verlag.

Panofsky, E. (1979). Ikonographie und Ikonologie: Theorien, Entwicklung, Probleme. Köln: DuMont.

Nader, K., Toprac, P., Scott, S., & Baker, S. (2022). Public understanding of artificial intelligence through entertainment media. *AI & Society*. https://doi.org/10.1007/s00146-022-01427-w

Naughton, J. (2019, January 13). *Don't Believe the Hype: The Media are Unwittingly Selling Us an AI Fantasy*. The Guardian. Retrieved from https://www.theguardian.com/commentisfree/2019/jan/13/dont-believe-the-hype-media-are-selling-us-an-ai-fantasy

Obozintsev, L. (2018). From Skynet to Siri: An Exploration of the Nature and Effects of Media Coverage of Artificial Intelligence [Master's thesis, University of Delaware]. http://udspace.udel.edu/handle/19716/24048

Ouchchy, L., Coin, A., & Dubljević, V. (2020). AI in the headlines: the portrayal of the ethical issues of artificial intelligence in the media. *AI & Society*, 35, 927–936. https://doi.org/10.1007/s00146-020-00965-5

Panofsky, E. (1975). *Sinn und Deutung in der bildenden Kunst*. Köln: DuMont.

Panofsky, E. (1979). *Ikonographie und Ikonologie: Theorien, Entwicklung, Probleme*. Köln: DuMont.

Pentzold, C., Brantner, C., & Fölsche, L. (2019). Imagining big data: Illustrations of "big data" in US news articles, 2010–2016. *New Media & Society*, 21(1), 139-167. https://doi.org/10.1177/1461444818791326

Renner, K. N. (2013). Journalistische Wirklichkeitserzählungen und fotografische Bilder. *Diegesis: Interdisziplinäres E-Journal für Erzählforschung*, 2, 33–50.

Rodriguez, L., & Dimitrova, D. (2011). The levels of visual framing. *Journal of Visual Literacy*, 30(1), 48-65. https://doi.org/10.1080/23796529.2011.11674684

Roesler, E., Heuring, M. & Onnasch, L. (2023). (Hu)man-Like Robots: The Impact of Anthropomorphism and Language on Perceived Robot Gender. *International Journal of Social Robotics*, 15, 1829–1840. https://doi.org/10.1007/s12369-023-00975-5

Romele, A. (2022). Images of Artificial Intelligence: a Blind Spot in AI Ethics. *Philosophy and Technology*, 35(4), 1-19. https://doi.org/10.1007/s13347-022-00498-3

Scheufele, B., & Engelmann, I. (2013). Die publizistische Vermittlung von Wertehorizonten der Parteien. Normatives Modell und empirische Befunde zum Value-Framing und News Bias der Qualitäts- und Boulevardpresse bei vier Bundestagswahlen. *Medien & Kommunikationswissenschaft*, 61, 532–550. https://doi.org/10.5771/1615-634x-2013-4-532

Schmitt, P. (2021, March 2). *Blueprints Of Intelligence. Exploring how researchers have illustrated artificial intelligence over the decades could help us build it better*. Berggruen Institute. Retrieved from https://www.noemamag.com/blueprints-of-intelligence/

Schnettler, B., & Bauernschmidt, S. (2018). Bilder in Bewegung: Visualisierungen in der Wissenschaftskommunikation. In Müller, M. R., & Soeffner, H. G. (Eds.), *Das Bild als soziologisches Problem. Herausforderungen einer Theorie visueller Sozialkommunikation* (pp. 197-208), Weinheim: Beltz/Juventa. https://doi.org/10.3224/zqf.v21i1.10

Sun, S., Zhai, Y., Shen, B., & Chen, Y. (2020). Newspaper coverage of artificial intelligence: A perspective of emerging technologies. *Telematics and Informatics*, 53, 101433. https://doi.org/10.1016/j.tele.2020.101433

Vergeer, M. (2020). Artificial Intelligence in the Dutch Press: An Analysis of Topics and Trends. *Communication Studies*, 71(3), 373-392. https://doi.org/10.1080/10510974.2020.1733038

Wilke, J. (2011). Die Visualisierung der Wahlkampfberichterstattung in Tageszeitungen 1949 bis 2009. In Ders. (Hrsg.), *Von der frühen Zeitung zur Medialisierung. Gesammelte Studien II.* (S. 183-211). Bremen: edition lumiére.

Xanke, L., & Bärenz, E. (2012). Künstliche Intelligenz in Literatur und Film – Fiktion oder Realität? *Journal of New Frontiers in Spatial Concepts*, 4, 36-43.

Acknowledgements

We thank Paul Klär for support with coding.

During the preparation of this work the authors used DeepL Translator as support for the translation of the original German-language codebook (provided in the appendix) into English. DeepL Translator was also used to help with the translation of individual words or phrases from German to English and in correcting grammar and spelling errors. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Funding details

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Declaration of interest statement

No financial interest or benefit has arisen from the direct applications of our project.