Exposing scientists: Exploring the effects of communicating research practice through photography

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Abstract:

In this research, the effects of using a step-by-step photographic to communicate the process of research method are explored. This method is developed to supplement an academic publication with photos of its research process. This is based on the idea that photographs of the research process might contain valuable visual information of research activities that would otherwise be documented only briefly- for instance in a methods and materials section. Three participants of varying academic backgrounds used the method to document their most recent research process, hoping to gain insight into the potential benefits of using photography in these fields. Based on the the resulting photos, their descriptions and discussions with participants, questions such as: Would this kind of photography help to increase the transparency of the research process? Who is this transparency beneficial for? And does it matter who is in these photos? are answered. Finally, a discussion is opend and next steps for developing adopting photography of the research process in research papers are suggested.

1. Introduction

Photos have the ability to show and help us remember our favourite family vacations, places, things and events. They contain visual information and can furnish evidence for things that might be questioned until we have seen them (Sontag, 1973). There is no controversy in saying that humans are visual creatures, fascinated by visual images, whether on the walls of caves, on rune stones, billboards or newspapers, the image is captivating. Today, in academia, the use of photography is varied and as diverse as the fields of research that apply it across the academic spectrum. In disciplines such as anthropology, archaeology and sociology it has been used as a method of doing, documenting and communicating research (Rose, 2003). In disciplines situated in the natural sciences, varying imaging techniques that find their origin in photography are used to observe phenomena and record data to represent and archive objects and illustrate science (Wilder, 2009) This variation in the application of photography can be attributed to differences in the subject matter among others, as some fields are not as visual as others. Not every star, bone, equation or line of code is an interesting subject for a photograph. Aside then from the subjects of research, what about the path that researchers find through the landscape of challenges, mistakes, problems, and solutions while doing research? Could researchers benefit from documenting this process of doing research?

> *'It frequently happens, moreover – and this is one of the charms of photography – that the operator himself discovers on examination, perhaps long afterward, that he has depicted many things he had no notion of at the time' (The Pencil of Nature, 1844: William Henry Fox Talbot (1800–77)*

Recording research activities might yield details of the process of generating academic knowledge that usually goes undocumented, that might not be seen as 'worthy' to write down, or might not be included in a conventional research paper. While a research paper often provides a written account, a visual account of the process of research might underpin findings by highlighting unique or important moments throughout such a process, potentially increasing its transparency. This research attempts to explore whether it can be beneficial for researchers to use photography to record and communicate the process of doing research.

Examples of researchers recording their research activities through photographs in such a systematic manner are rare. Yet, in the 2014 edition of Annals of Improbable Research (vol.20, no. 2), I found Ingo Älthofer, a mathematician, sitting in front of his washing machine in which LEGO bricks are tumbling and randomly joining together. The bricks in the washing machine form structures in interesting and beautiful ways, this process shares a resemblance to a decision-making algorithm, which inspired Ingo to write a humorous paper about it. While this is probably a posed photo with humorous intent, it shows a situation in which a researcher photographs his research activities and communicates these in a paper. In this case, washing LEGO in a home setting, probably using the home washing machine. With a little imagination, however, we could think of how researchers across the academic spectrum might have looked when photos of them engaged in research activities were published

Figure 1. Ingo Althöfer, observing a washing run. (Photo courtesy: K.-H. Wüllhorst)

Would this kind of photography help to increase the transparency of the research process? Who is this transparency beneficial for? And does it matter who is in these photos? Would photography in general produce a better understanding of certain research practices? The visual information regarding the research process is mostly missing in papers, often described with just a few words. Therefore, in this research, I will explore whether photography can be beneficial when attempting to communicate the process of knowledge generation in research publications.

In the next sections, I will go into how photography has been used to record and communicate professional processes. Subsequently, we will look at the different approaches of how photography has been used in academia. Then, I introduce a photographic method that is intended to instruct researchers to systematically take photos, write descriptions of research activities and add these to a research paper. After this, I introduce an experiment in which three Ph.D. candidates used the method to record their most recent research project. I then evaluate these results during photo-elicitation interviews with each of the participants in an attempt to answer the questions posed above in regard to the benefits of using photography to communicate the process of research. Finally, I start a discussion on the implication of this exploration and how it might inspire new areas of future research.

1.1 Using photography to communicate professional processes

In this section, I illustrate how photography is used to document and communicate processes that relate to impressions, phenomena, events and cultural issues found in professional contexts.

Stock photography

Stock photography is a particular kind of photography often used to enhance or illustrate a specific message or advert, a corporate identity, presentation or website. Stock photography has a very 'you know it when you see it' aesthetic, apart from the obvious watermarks. The images often imitates a candid documentary aesthetic, which is drenched in a sense of fabrication. Something that makes you go 'that's not how that really looks', but it does give you an idea.

Figure 2. Stock photo of a business meeting.

I use stock photography here to show that while successful in their own rights, they illustrate a concept or idea in a manner that does not prioritise representing the unique reality of the underlying processes. Figure 2 for example, could illustrate any meeting in any company, and while looking nice, it does not provide much insight into that specific meeting. In contrast, in this study, I'd like to find out whether using photos that do emphasise the unique nature of the processes they represent can be useful in communicating research.

While stock photos harness an otherworldly quality, banking on visual tropes and humour. Photojournalism harnesses the communication of real events through photos and emphasises the ability to tell a story through it.

Documentary photography

Photojournalism is a form of journalism in which written text is subordinate to the photographic presentation of (news) stories (Kratochvil & Persson, 2021). It is used to, for instance, communicate news through single image articles. Documentary photography, instead, uses a series of images to look at a specific subject such as war, cultural events or people from varying angles over time. Documentary photography work is often presented in a photo essay, a book or magazine, or an exhibition. Through longer periods of time and larger sequences of photos pertaining to an overarching topic, it has the ability to communicate insights into its complexity.

Documentary photographers use their medium to research and explore sociocultural issues by taking and presenting photographs of their processes and discourse. An example of such is provided below. In 2013 Henk Wildschut explored the topic of food production in The Netherlands. Using documentary photography, he recorded the processes pertaining to the topic using photography and inquiry, following farmers and food processors through various stages of food production. The multitude of photographs in these works supply valuable information about these processes we could read about, but seeing them rendered in front of our eyes in a narrative format supported by text makes a difference. A photo and description from the series are displayed as an example here:

'Semi-finished. With brown poultry it is possible to breed a variety that makes a visual distinction between a hen and a cock. A young female is brown and a young male white. This difference is essential at a hatchery for layer chickens, as males don't lay eggs. The selection process is now less complicated and can be carried out by eye by non-specialized staff. Using a conveyor belt, 20,000 brown and white chicks can be separated every hour. The above-named difference is irrelevant for broilers as both sexes are bred for meat production.' (Wildschut, 2021)

Figure 3. 'Semi Finished'.

Using a multitude of photos, documentary photography uses photos to depict a larger view of the reality of a topic. It allows the viewer, using his own wits, to piece together the narrative through photo and text.

Business operations

Photography can, as earlier illustrated, help to explain a larger topic by providing visual information of its underlying processes. In the professional world, that quality is often used to illustrate the services a company or business for instance is capable of providing. Through photos of stages of these services, like in the example below, these can serve to illustrate particular commercial qualities of work. In the example here, photography is used to document and communicate the process of restoring a classic car by a restoration workshop. By using meticulous photographic documentation to illustrate both the quality and progress of the restoration of a car which is displayed on their website. Countless companies and factories employ photography to highlight specific processes or products to advertise their services or products through these kinds of photographs.



Figure 4,5 & 6. Several stages of the restoration of a car.

Body-worn cameras

In law enforcement, body-worn cameras help document activities carried out by and concerning officers and their environments. While this method employs video instead of photography, BWCs are a good example of using images to increase the transparency of a professional process. According to American sources, their goal is to record the performance of an officer and their surroundings 'to increase the transparency of interaction between officer and citizen, internal accountability, facilitate investigation and enhance citizen perceptions of police legitimacy.'(National Policing Institute, 2020),(Braga et al., 2017) They seem to have compelling effects on the training of officers and reducing the time spent on resolving complaints. (Braga et al., 2020)

BWCs have helped to shed light on the details of high-profile incidents in for example, the case of George Floyd. In which a black man was murdered by a white police officer. In the courtroom, the video footage of body cameras worn by present officers facilitated evidence against the four officers in question as well as communicated the incident with the public after it was ordered released, sparking major protests. (Willis et al., 2021)

While BWCs can be useful in creating more transparency in high-profile incidents, its many other effects remain empirically untested (Braga et al., 2020) and accompanying programs are still under development. Cameras can make a difference if wearers acknowledge they are not objective observers, in addition, it seems wherever cameras are applied this seems to have a need of repetition. Good policies can ensure BWCs are turned on at the right moment, footage can be obtained at the right times, and cameras simply remain off when privacy needs to be protected. In short, Body-worn cameras can be part of more transparent policing, but their users, agencies and institutes need training and policies to know how and when to properly apply them. (ACLU, 2020)

Forensics

Where documentary photography explores a single topic over time through various process and from different angles, in forensics, photography is mainly used meticulously to 'provide visual documentation of the scene and locations of evidence within the scene.' (NFSTC, 2013) They are used as documents for analysis and recreation of the scene and serve to document what was where in relation to each other. It serves to partially freeze a representation of the scene in time for later reference. In forensic photography, care is taken to follow specific methods and protocol to document the scene as best and as quickly as possible. The photos then form records, archival material and can illustrate particular pieces of evidence or relations between pieces of evidence, but they are not evidence of themselves. An example:

> *'A photographer in Florida shot the inside of every cabinet and the refrigerator at a homicide scene in a home, just as a matter of procedure. It was later discovered that the victim had a receipt for a six-pack of beer, matching the beer shown in the photograph of the refrigerator. Relatives noted that the victim did not drink beer. Further investigation led the team to the convenience store where the beer was purchased and the surveillance tape showed the victim with an unknown person purchasing the beer. It turns out that the victim had picked up a hitchhiker, purchased beer for that person and come back to the house. The photograph of the refrigerator contents had created the link enabling the investigators to find the suspect.' (NFSTC, 2013).*

Conclusively, photography is a useful tool that can improve our understanding of topics or events by providing detailed visual information of the processes that underlie these. At least in these examples, photos can help the reader to gain a sense of perspective or insight into the processes that leads to better understanding of the overarching topic shown in the photos.

1.2 Current uses of photography in academia

Beyond recording professional processes or the author of this research (Figure 7), the importance of photography, whatever its kind, in portraying the world as realistic images, has been, and remains, critical. (Ferreira, 2020) In the natural sciences, the emphasis of its use lies in observing natural phenomena, archiving and communicating results. Variants of photography are used to extend our visible spectrum of light, to alter the scale of difficult to observe phenomena or freeze time to capture objects in high-speed motion. Photos help to illustrate a subject under study, archive a result, or help to perform quantitative or qualitative analysis. The natural sciences use a plethora of camera technologies, able to record varying stimuli. The value of it relies mostly on the procedural nature of how a camera works. A light-sensitive medium (or digital sensor) reacts to photons or other particles, which leave a chemical or digital impression that can then be further rendered into a photograph through processing. Photographs thus can be seen as records of a stimulus, like a tidal gauge, or Geiger counter it renders that stimulus not as numerical or audible, but as a visual image. (Kelley Wilder, 2009).

Figure 7. Preliminary phase

The author is sitting in his home and reading about social sciences research methods on a tablet to prepare for writing a photography method. A camera was given to the author's roommate and was asked to take a photo while he studied. The photo is intended to show the kinds of work in the authors' research process as well as serve as an example photo in this method. Photograph by the author in 2021.

For example, the Event Horizon Telescope, which consists of a number of physically separated telescopes around the world, produced massive amounts of data of a black hole in Galaxy Messier 87 that were combined and rendered to produce figure 8 (Event Horizon Telescope, 2019). Not exactly a photograph, but the image you see here is a result of capturing and rendering a stimulus, in this case, radio waves, that are rendered into a visual image. It is these technical processes that imbue the image with a scientific value, the image becomes a result, evidence of both the technical achievements that make up the camera and its rendering technologies and the stimuli captured and rendered through them.

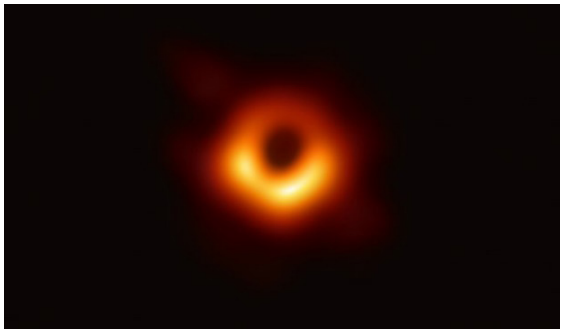


Figure 8. Image of a black hole taken by EHT.

The social sciences mostly use the traditional digital or film camera applied through a plethora of methods and methodologies to mediate culture and society. Especially in anthropology and sociology, photography has over the last century firmly established itself as a useful tool for social and documentary photography. However, according to sociologist Howard Becker, this documentary mode sometimes tended to 'restrict researchers to a few reiterated simple statements. Rhetorically important as a strategy of proof, the repetition leads to work that is intellectually and analytically thin" (Becker, 1986). In recent years it has split into various innovative methods of doing, recording and communicating research and is used to generate data by both researchers and participants. 'By grounding their photographic practice in prior research, by using theoretically supported scripts, by reflexively documenting their approach, and by contextualizing their visual products, some photographers have produced bodies of work that truly excel in expressive quality and research potential both in social documentary and art photography. (Pauwels, 2020).

The difference in use of photography between the natural and social fields can be seen in how studies in these fields have developed the use of photography. In 'A Balinese Character' by Bateson and Mead (1942), an early cultural anthropology study from the 1940s, photography was used to document aspects of Balinese culture over the course of two years. Photography was used 'as the primary recording device, not as devices for illustrating our theses' (Jacknis, 1988), to capture all activities locals undertook. Together with field notes, the photos were combined into a final monograph that explored various themes of Balinese culture, using photography to explain the processes pertaining to the cultural themes. An example

of this is given below in Figure 9.

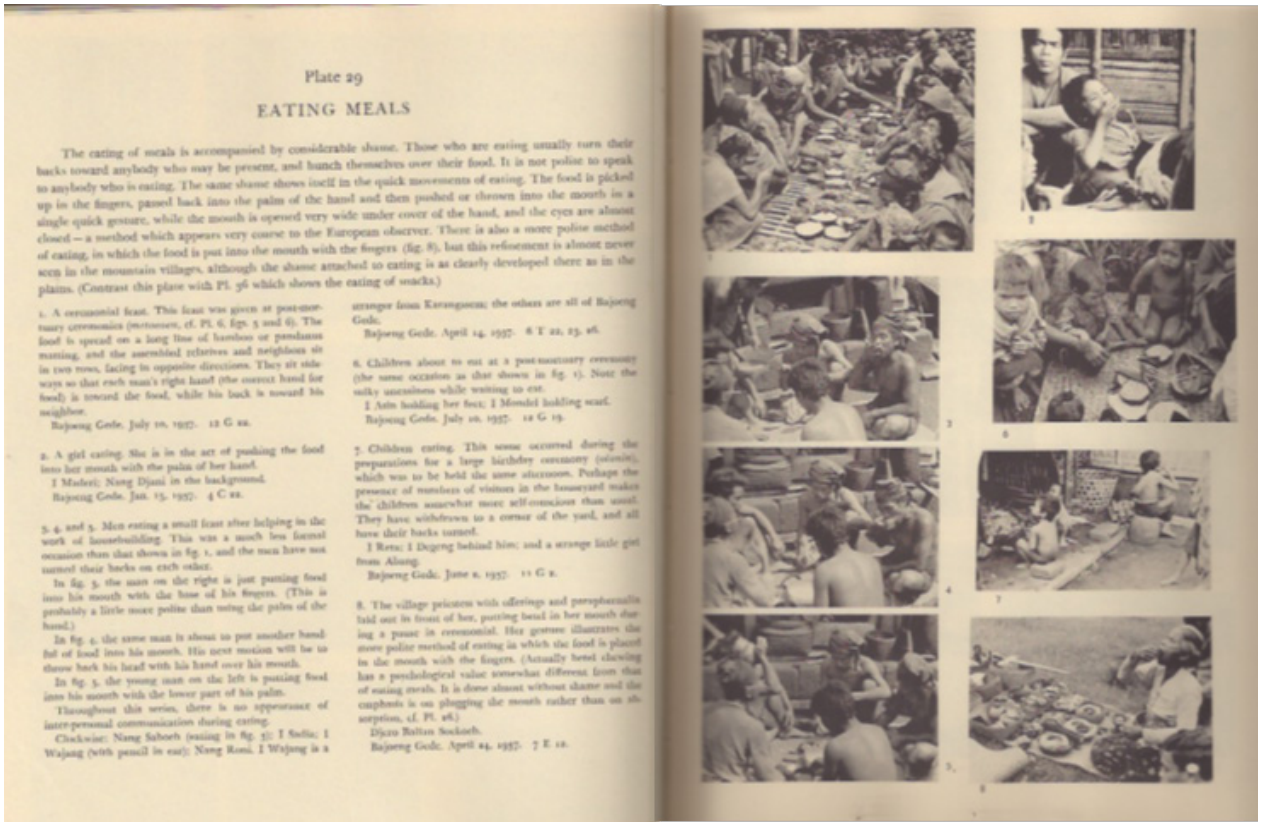


Plate 29

EATING MEALS

The eating of meals is accompanied by considerable shame. Those who are eating usually turn their backs toward anybody who may be present, and hunch themselves over their food. It is not polite to speak to anybody who is eating. The same shame shows itself in the quick movements of eating. The food is picked up in the fingers, passed back into the palm of the hand and then pushed or thrown into the mouth in a single quick gesture, while the mouth is opened very wide under cover of the hand, and the eyes are almost closed — a method which appears very coarse to the European observer. There is also a more polite method of eating, in which the food is put into the mouth with the fingers (fig. 8), but this refinement is almost never seen in the mountain villages, although the shame attached to eating is as clearly developed there as in the plains. (Contrast this plate with Pl. 36 which shows the eating of snacks.)

1. A ceremonial feast. This feast was given at post-mortuary ceremonies (metesseen, cf. Pl. 6, figs. 3 and 6). The food is spread on a long line of bamboo or pandanus matting, and the assembled relatives and neighbors sit in two rows, facing in opposite directions. They sit sideways so that each man's right hand (the correct hand for food) is toward the food, while his back is toward his neighbor.
Bajoeng Gedé. July 10, 1937. 12 G 22.

2. A girl eating. She is in the act of pushing the food into her mouth with the palm of her hand.
I Maderi; Nong Djani in the background.
Bajoeng Gedé. Jan. 13, 1937. 4 C 22.

3, 4, and 5. Men eating a small feast after helping in the work of housebuilding. This was a much less formal occasion than that shown in fig. 1, and the men have not turned their backs on each other.
In fig. 3, the man on the right is just putting food into his mouth with the base of his fingers. (This is probably a little more polite than using the palm of the hand.)
In fig. 4, the same man is about to put another handful of food into his mouth. His next motion will be to throw back his head with his hand over his mouth.
In fig. 5, the young man on the left is putting food into his mouth with the lower part of his palm.
Throughout this series, there is no appearance of inter-personal communication during eating.
Clockwise: Nang Saboeh (eating in fig. 5); I Sedia; I Wajang (with pencil in ear); Nang Rosi. I Wajang is a stranger from Karangasem; the others are all of Bajoeng Gedé.
Bajoeng Gedé. April 14, 1937. 8 I 22, 23, 26.

6. Children about to eat at a post-mortuary ceremony (the same occasion as that shown in fig. 1). Note the milky uneasiness while waiting to eat.
I Asin holding her feet; I Mondel holding scarf.
Bajoeng Gedé. July 10, 1937. 12 G 19.

7. Children eating. This scene occurred during the preparations for a large birthday ceremony (otonan), which was to be held the same afternoon. Perhaps the presence of numbers of visitors in the houseyard makes the children somewhat more self-conscious than usual. They have withdrawn to a corner of the yard, and all have their backs turned.
I Reta; I Degeng behind him; and a strange little girl from Alsung.
Bajoeng Gedé. June 2, 1937. 11 G 2.

8. The village priestess with offerings and paraphernalia laid out in front of her, putting betel in her mouth during a pause in ceremonial. Her gesture illustrates the more polite method of eating in which the food is placed in the mouth with the fingers. (Actually betel chewing has a psychological value somewhat different from that of eating meals. It is done almost without shame and the emphasis is on plugging the mouth rather than on absorption, cf. Pl. 26.)
Djero Bolten Soekoeh.
Bajoeng Gedé. April 24, 1937. 7 E 12.

Figure 9. Page 112 and 113 of ‘A Balinese Study’.

Later, in another study by Charles Suchar, photography was used to document gentrification and its effect in particular suburbs in Chicago. Rather than describing this process in textual means, and using photography to document its effect, Suchar worked towards answering his research question through an innovative use of photography. By using a film script style guide, called a ‘shooting script’, which is essentially is a list of questions about the subject matter, he was able to answer specific questions about the effects of gentrification, documenting and iterating his shooting script to inform further research efforts’. (Suchar, 1997)

Photographs themselves can also be used in a method called photo-elicitation, to elicit responses from participants to for example gain insight into a problem affecting a particular social group, or to learn more about participants’ motivation for taking photos. Rather than adopting photography as an outside-in technique like in the Bateson & Mead example, this method uses photography to enable participants to take photos in reaction to a prompt or script, like Suchar. A researcher can then insert these photos taken by participants into a discussion format to elicit responses. This technique is widely used across the social sciences, (Rose, 2003) in nursing, (Lockett, 2005)(Hansen-Ketchum, 2008), psychiatry (Edmondson, 2018) and other areas of research (Glaw et al., 2017). There also exists a variant where researchers produce photos to discuss in interview format themselves (Thomas, 2009). These interviews evoke different kinds of knowledge from their participants than just talking would do, often participants discuss their photos actively, which offers them a sense of authorship and participation in the research as well as a sense of empowerment towards problems or marginalisation. (Rose, 2003) (Edmondson, 2018).

From its initial first success until now, photography has been an undeniable aid in visually documenting our natural and social world. Fields in the natural sciences seem to advance photographic technologies to render the deeper, smaller and larger parts of the natural world, transforming the disciplines they serve and communicating these findings to the world. The social sciences continue to develop photographic methods that move beyond documentation and employ the reflexive qualities of the image. While many other fields such as medicine, law and the humanities, study, use and benefit from photography, examples and use cases have, for the purposes of this study, been left out of focus. This is done so that I might focus on a pragmatic and achievable experiment within these fields which perhaps might result in an application of its results towards these aforementioned and other fields, if at all beneficial.

1.4 Photographs and their contextual information

Photography is a powerful tool used all across the academic spectrum for recording stimuli, illustrating visual information, serving as a methodology to do research and allowing participants to have their voices heard. The meaning of a photo is, however, not static and can change depending on who views it and what information is given with it. In other words, the context of a photo significantly impacts the meaning of that photo (Becker, 2008). Susan Sontag wrote, ‘a photo does not preserve meaning, only that which narrates us can make us understand.’ (Sontag, 1980)

There is no way to present or look at a photo without context. ‘Like all cultural objects, they get meaning from their contexts. Even paintings or sculptures, which seem to exist in isolation, hanging on the wall of a museum, get their meaning from a context made up of what has been written about them, either in the label hanging beside them or elsewhere, other visual objects, physically present or just present in viewers’ awareness, and from discussions going on around them and around the subject the works are about.’ (Becker, 2008) To define the concept of context for photographs concretely, I have adopted three categories of contextual information Terry Barret distinguishes and altered them slightly to fit this research. Below these are presented and illustrated with an example:

The internal context

All we can observe on the two-dimensional grid of pixels we call a photograph, from image quality to the composition of it.

The original context

Information relating to the moment of the photo’s making.

The external context

A photograph’s presentational environment; for example, an external photo in a research paper comprises its format, titles, images, and texts.

When looking at two pages from the earlier mentioned Bateson and Mead monograph (Figure 10) (1943), the contextual categories become evident. When considering the internal context of photo 1 on page 113 we can discern people eating rice with their hands, most likely in an Asian environment given the visage of the people and objects. The monochrome photo seems candidly taken, and the people in the photo seem not to mind the photographer. The action of eating or food itself seems central to the image. The original context, the information relating to the taking of the photograph can in the case of the descriptions in this monograph, can primarily be found in the last two sentences. It is mentioned earlier in the text that these describe native individuals more often depicted in photos for the sake of cross-referencing, the place of capture, date and index number of the photograph on the corresponding roll of film (number 12 of 26 total, G of A – Z, photo 22). The external context of the image includes its description on the other page at number ‘1. A ceremonial feast...’, but also includes the other photos on the page, their descriptions, the introductory text and titles and what we’ve been reading from this monograph up until this point. This contextualises the photo as one of eight photos regarding the activity of eating meals in Balinese culture. We’d learn this specific photo depicts a ceremonial feast during which specific behaviours, like eating with the right hand only, are observed by the researchers which can also be seen in the other photos.

I’ve tried to show that while photographs are useful when documenting professional processes and in illustrating and generating academic results, the meaning of a photograph is influenced by the contextual information it is presented with. These contexts can be categorised into three types of information and in the next section, I will go into how I’ve used these to create a set of instructions to inform participants in an experiment to explicitly create photos and contextual information.

2. Instructions for photographing the process of science

I created this set of instructions (appendix 1) for the purpose of this study, as can be seen in Figure 10. This method instructs participants on how to take photos of research activities, write descriptions for these photos, and add them to a publication. These three steps are based on the three kinds of contextual information mentioned in the previous section: taking a photo (Internal context: taking photographs), writing its description (Original context: putting the photo into words), and finally adding these into the final publication (External context: putting it all together). This process is graphically illustrated in figure 11.

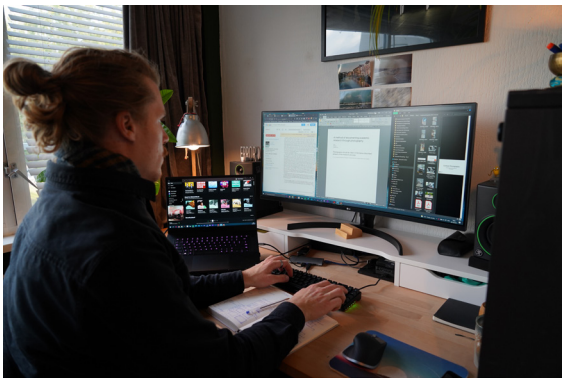


Figure 10. Preparation phase

The author is sitting behind his computer at his desk in a home setting. He is listening to music and reading 'Image-based research' by Jon Prosser (1996) as he outlines the photography method (appendix 1). A camera with a timed shutter on a tripod records the situation. The photo is intended to show the preparation goin into creating the method. Photograph by the author in 2021.

Every researcher goes through a complicated process of steps during academic research. Because I wanted the method to be applicable to researchers from across the academic spectrum, I generalised this process into four general phases: a preliminary research phase, a preparation phase, a work phase, and an analysis phase. These four phases for this method were inspired by the four general sections which can be found in most research papers: the introduction, the materials and methods, the results and discussion, and the conclusion. (Nature, n.d)

The phases in this method are not meant to fit directly onto every individual process of research directly, nor are they fixed steps. Scientific activity varies so much across disciplines, times, places, and scientists that any attempt to set up this method with fixed steps would be futile (Stanford Encyclopedia of Philosophy, 2021). The four phases are general stages of research that should serve as easily understood waymarks for researchers from across the academic spectrum. Then, assuming they are well aware of their own research methods and practices, they can gauge which specific research activity within a phase is important enough to represent that phase through a photo.

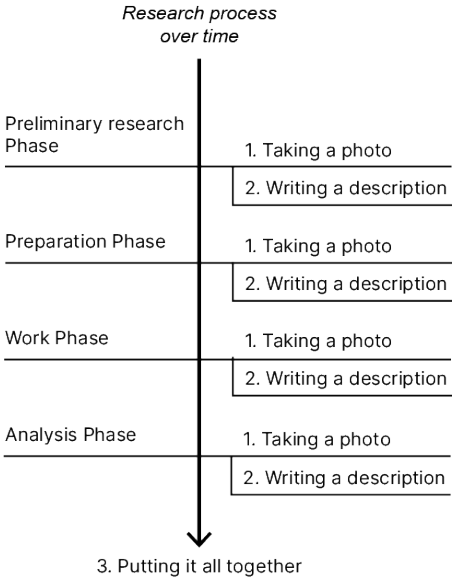


Figure 12. The photographic instructions illustrated.

2.1 Methods and Materials

Three Ph.D. candidates from varying academic backgrounds (cultural anthropology, chemistry and computer science) were asked to use the aforementioned photography method (appendix 1). Participants' backgrounds varied in an attempt to get a broad impression of how photography might benefit communication of the research process in different academic areas.

Participants were asked to take photos for each of the four phases of the research process described in the method. This was done retroactively, meaning participants were asked to fabricate photos resembling their most important research activities in the four phases of the method. Subsequently, they were asked to write a description for all four photos and to integrate photos and descriptions into the publication of the most recently completed research project according to the method. Finally, I interviewed the participants during individual photo-elicitation sessions, as can be seen in figure 12. While showing their photos and descriptions, I asked participants questions about how and why these were taken, as well as how they experienced working with the method and the value of documentary photographs in their publications. The interview questions can be found in appendix 2.

3. Photographic method results

Figure 13 shows an example provided by one of the participants in which photos and descriptions were added to their publication. The results on the pages after that example show the photographs and descriptions from each participant, including their background and subject of research. In the section thereafter, due to practicalities, I only included one example of a participant adding a photo and description of the process of data collection (work phase) to a publication. The evaluation in the next section consists of an evaluation of the photos and descriptions provided by the participants, extended with the results of the photo-elicitation interviews.

Figure 13. Work phase

The author is performing a photo-elicitation interview with participant 2. Both are engaged in discussion as participant 2 points out how laterocidine is elongated using chemical processes using a 3d printed model. The author uses a list of questions and the photos taken by participant 2 to elicit responses. A camera with a timed shutter on a tripod records the situation, a Samsung Galaxy S10e records the audio with permission. The photo is intended to show the context of the interviews in order to further illustrate these. Photograph by the author in 2022.

3.1 Example of step three of the photographic method

This page is taken from participant 3's research paper, a photo of the work phase is added to the 'Data collection' section. This is the only example of a participant adding their photo to their research paper, as other participants' publications were unfinished at the time of writing. A systematic description according to the photographic method is absent.

Level	Example	ID
Actor	"...There was a farm with sheep..."	060301
	"...He is dressed up with real boots..."	010701
Agent	"...A baby came and then the father left..."	021302
	"...In the car it was very stupid since we had to wait long..."	010501
Person	"...She very much wanted to play outside, but her mother didn't allow it..."	010201
	"... And Amelie knew too that they [her parents] knew this..."	021301

Table 1: Three general levels of character depth used as story labels, with translated examples from our story data. ID refers to story ID in our dataset.

Figure 1: The author giving the story workshop in a classroom.

Third, as explained above, we believe that classroom storytelling is a natural context that challenges children's mindreading skills more than standardized tasks do, since the latter have no social goal such as enticing an audience, and don't entice children to be creative. Thus, our open-ended task probably leads to diverse text samples, hence a more challenging classification task.

3 Data

3.1 Data collection

We collected 510 stories from children aged 4-12, from various Dutch primary schools and day cares. Story collection was embedded in a story workshop, which consisted of three stages. In the first stage, we philosophised in an open fashion with the children about what they knew and liked about stories. In the second stage, children were invited to use their imagination to tell a story together with the experimenter. In the third stage, children were invited to tell individually a story about any subject and with any progression they liked, and tell it to their class peers. See Figure 1 for illustration. The stories were recorded with a Zoom H5 handheld recorder. Our project was ethically approved by the *UNIVERSITY* Ethics Committee ref. no. 2021-18, and parents were informed before classroom visits. Besides the recorded story, no other information from children was collected, except from the parents who agreed to share additional data such as the birth date of the child, gender, and so on by signing a digital consent form.

3.2 Preprocessing

The recorded stories were manually transcribed into two versions: 'raw' verbatim transcriptions, and 'normalised' versions in which false starts, fillers, wrongly used articles, and so on were corrected or removed, without changing the syntax or semantics of the story. The raw and normalised corpus are both provided on OSF for reference.[1] The normalised stories were used for manual labelling and classification.

3.3 Manual labelling

All stories were uploaded in the online CATMA markup environment (Gius et al. 2016) and each story received one label according to the highest level of mindreading skill as displayed by a story character. We used a slightly adapted version of Nicolopoulou and Richner's (2007) established typology of story characters here, in which three general levels of 'character depth' (i.e. character's mindreading skills) exist:

- *Actors* are passive characters, characterized by descriptions, that lack clear intentionality and goal-directedness;
- *Agents* exhibit simple perceptions and emotions, simple to complex intentions and goal-directed behaviour, and can respond with ac-

[1]Here you can find our OSF repository with stories, data, annotations, and notebooks.

Figure 14. Example of a photo in a research paper.

3.2 Results

Zane Kripe (Participant 1)

Ph.D. candidate at the Institute of Cultural Anthropology and Development Sociology Leiden

Research: Geek and tech start-up culture in Singapore and South East Asia.

Participant 1 Photo 1. Preliminary research phase

Desk with a laptop and researcher holding her notebook and a pencil. Image is captured for the purpose of this research (2022) to represent the preliminary stage of the research that involved learning about various geek and hacker events and social groups in South-East Asia through online research. Researcher used paper and pencil to visualise the timelines of events and capture the names of the various groups she came across online to establish who should she contact once in the field. *This photo was taken retroactively.*

P1P2. Preparation phase

Desk with a laptop, notebook and a folder with printed out materials regarding the research. There is also a grumpy cat sitting on the table indicating that the image is taken in a domestic context. Made by the researcher in 2015 at her home, it represents the intertwined personal and professional nature of ethnographic research, where preparation for it means not only reading and emailing, but also preparing to leave your home and family behind.

Zane Kripe (Participant 1)

Ph.D. candidate at the Institute of Cultural Anthropology and Development Sociology Leiden

Geek and tech start-up culture in Singapore and South East Asia.

P1P3. Work phase

A cluttered room with a whiteboard, projector, tables and chairs is filled with a handful of people. Some are standing, some sitting on the chairs and beanbag on the floor. The researcher is sitting (right side of the image) and seems to be engaged in a conversation with someone who is not visible in the image. It is an image captured by a friend and research informant in 2013 at Singapore's Hackerspace. It represents the casual, but also gendered nature of Singapore's technology scene.

P1P4. Analysis phase

Researcher is spending yet another day in the silence of library, working through the fieldwork notes, images and trying to write a paper. Researcher's laptop is covered with colorful stickers representing the spaces and companies she visited and worked with during her fieldwork. The stickers visualise the various connections researcher has made, and after the fieldwork serve as a nostalgic reminder about the times gone and also the work still ahead. Image captured in 2017 by her colleague shortly before lunch break. It represents the long hours of work that go into the analysis after the exciting fieldwork.

Karol Al Ayed (Participant 2)

Ph.D. candidate at the Institute of Biology Leiden

Synesthesia of natural antiobiotics, in this case laterocidine and brevicine.

P2P1. Preliminary research phase. Planning the total synthesis of laterocidine

Karol planning the synthesis of laterocidine based on the structure published by Li and coworkers.6 He is using the Google Chrome webbrowser on an HP probook laptop to access the Nature communications article. The picture was taken using a Samsung Galaxy S8 mobile phone. The photo is intended to emphasize the impact of Li paper on our research project. Photograph by Ned Buijs in 2022. We thank Ned Buijs for generously providing the photograph.
This photo was taken retroactively.

P2P2. Preparation phase. Preparing the resin for solid-phase peptide synthesis

2-Chlorotrityl chloride resin (Iris biotech GmbH, 100-200 mesh)being vacuum filtered through a glass filter after loading with glycine and capping with methanol. The solid support needed to be prepared before elongation of the peptide. The picture was taken using a Samsung Galaxy S8 mobile phone. The photo is intended to potentially help reproduce the results described by the authors in this article by providing an example of how the resin looked after loading. Photograph by Karol Al Ayed in 2021.
This photo was taken retroactively.

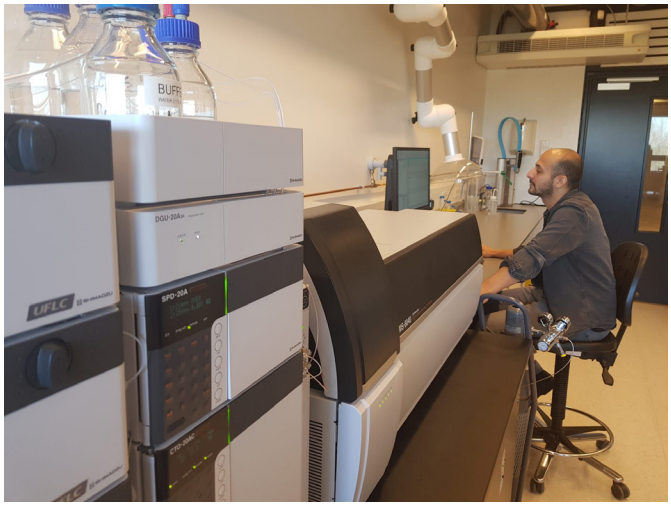
Karol Al Ayed (Participant 2)

Ph.D. candidate at the Institute of Biology Leiden

Synesthesia of natural antiobiotics, in this case laterocidine and brevicine.

P2P3. Work phase. Synthesis of Dap9-laterocidamide using solid-phase peptide synthesis on 2-Chlorotrityl resin

The manual SPPS set up used to synthesize dap9-laterocidamide on 2-chlorotrityl resin. The elongation of the peptide from glycine loaded onto the resin was performed in parallel on a 0.75 mmol scale in four plastic vessels containing a filter. A manifold installed in a fumehood was used to bubble nitrogen gas, as to agitate the suspension of resin in DMF. After every couling, deprotection and washing step the vessels could be drained of solvent under vacuum while retaining the resin. The picture was taken using a Samsung Galaxy S8 mobile phone. The photo is intended to potentially help reproduce the results described by the authors in this article by providing a visual example of how the SPPS was perfomed. Photograph by Karol Al Ayed in 2021.
This photo was taken retroactively.



P2P4. Analysis phase. Analysing the LC-MS spectra of the synthesized

Karol analysing the spectra of the synthesized peptides behind the LC-MS. The masses of the synthesized peptides were confirmed using mass spectrometry on a Shimadzu LC-20AD system with a Shimadzu Shim-Pack GISS-HP C18 column (3.0 x 150 mm, 3 µm). The picture was taken using a Samsung Galaxy S8 mobile phone. The photo is intended to showcase the instrument used to perform the analysis. Photograph by Ned Buijs in 2022. We thank Ned Buijs for generously providing the photograph.
This photo was taken retroactively.

Bram van Dijk (Participant 3)

Ph.D. candidate at Leiden Institute of Advance Computer Sciencs

The relationship between character traits in spontaneous children's stories and empathic an cognitive abilities in children.

P3P1. Preliminary research phase. Discussing ideas, methods, problems, and having fun

The author and colleague deliberating in the lounge part of their office. With my colleague Tom I often discuss approaches for analysing text, hypotheses, intersections of our work, and problems with coding. Usually we come up with a useful solution or an interesting view, or just something to laugh about. It is exactly the exchange of ideas that is a catalyst for my own work and wellbeing. We like to give our workspace a bit of the ambiance of a nice café or living room, which is why we bring occasionally beverages and snacks, and why we embellished the office with a lot of plants (not visible in the photo). This photo intends to convey the deliberation process before the actual research starts. Photo was taken with Tom's Iphone in 2022.
This photo was taken retroactively.

P3P2. Preparation phase. Collecting scores on cognitive tests

A colleague of the author is sitting behind a test setup, figuring a table, tipi tent, and test materials, in a small theatre hall inside a primary school in Noordwijk. The tipi tent is for setting the scene in line with the announcement of bringing a 'story tent'. Test materials are, among other things, the Peabody Vocabulary Test (Dunn & Dunn, 1959), the Reading the Mind in the Eyes test for Dutch children (Van der Meulen et al. 2017), and the Strange Stories Task (Happé, 1994). For privacy reasons the child is not visible. The goal is to conduct various cognitive tests with children that yield data about their vocabulary and mindreading skills. The colleague uses pen and paper forms to note the answers children provide on the mentioned tasks, as well as a Zoom H5 to collect fantasy stories if children want to tell them. Photo taken by author in 2021.

Bram van Dijk (Participant 3)

Ph.D. candidate at Leiden Institute of Advance Computer Sciencs

The relationship between character traits in spontaneous children's stories and empathic an cognitive abilities in children.

P3P3. Work phase. Collecting spontaneously told children´s stories

The author is in a classroom of a primary school in Leiden together with a colleague for data collection. The goal is to expose children to the topic of storytelling. In line with the book week theme 'history', he is dressed up as a knight. The author is examining what children know and like about stories, in order to stimulate them to make up a fantasy story themselves. The author records these stories with a Zoom H5 recording device. The photo was made by a teacher and sent later to the author, with a mobile phone of unknown type. The photo is intended to show the process behind collecting stories. Photographed by unknown teacher in 2020.

P3P4. Analysis phase. Analysis and writeup

The author sits behind is desk in Huygens room 126, looking at his screen with a draft for a new paper. Author uses a desktop PC and additional personal laptop. This is the typical setting for the analysis of texts and writeup of the results, from data from the previous phase. In contrast to the standard picture, writeup and analysis often alternate in my work. While writing I for example get an idea for how I can refine a calculation. The draft serves as a mind map that has weaker parts that need better arguments and are often rewritten, and stronger parts that form the building blocks of the work and don't change much. This picture intends to convey the analysis of data and writeup of results. The author works with Overleaf in the browser. The photo was made with the Iphone of a colleague in 2022.
This photo was taken retroactively.

4. Results evaluation

I have evaluated the previous results in photo-elicitation sessions with the participants. These resulted in insights into the questions I have asked earlier in the introduction of this research. In this section, I will attempt to answer these and additional questions that came up during the research. In doing this I had many discussions with peers as can be seen in Figure 14. Afterward, I will discuss the key points mentioned as well as try to highlight the implications of these.

Figure 14. Analysis phase

The author is discussing his ideas to write the analysis so far with a friend. Talking through and reflecting on ideas for this section helps to organise his thoughts and ideas. The author uses pen and paper to note down ideas. The situation is recorded by a timed-shutter camera on a tripod. The photo is intended to represent the author's process of writing. Photo taken by the author in 2022.

Could adding these photographs to research papers help to increase the transparency of the process of doing research?

As we've seen in the examples from professional contexts, photos are able to illustrate and provide insight into various larger subjects or topics by illustrating their processes. By adding photos of research activities during the four phases of research projects, researchers give a reader an overview of the processes that underlie these projects. By writing the descriptions, a researcher ideally gives a reader insight into these processes by describing the activities.

The photos in these results revealed a variety of 'conventional' and unique research activities found in research projects. While the preliminary research and analysis phases were represented through photos of researchers behind computers, the preparation and work phases were represented through photos of unique moments pertaining to the respective fields and subjects of the participants. This might give insights into their specific processes of data collection and fieldwork. For me personally, these garnered a better understanding of these research projects in their entirety. Additionally, during the interviews, participants reacted positively to using photography of their processes and saw benefits in increasing the replicative value of research and helping to explain their research activities to their audience. As an example, the participant from the natural sciences encountered a unique result in a chemical process during his preparation phase, which he photographed. While also documented otherwise, photos there might help efforts to reproduce results by providing visual information.

Like when hearing a drill through a wall, or seeing the sun through a window, these results show snapshots of the process of research being done through these photos and their descriptions. While considering that most fields conventionally don't include these, photos and descriptions applied through this method could make a start to increase the transparency of the research process. This was also aptly captured by what one of my participants said: 'Science is as much about what we study as it is about how we communicate it and, in that regard, adding photos can add missing dimensions of what is communicated'.

Who is this transparency beneficial for?

These results hint at increased visual transparency of the research process, but who might benefit from this transparency? Researchers from similar fields as the author, other academic fields? or a wider audience? When one is familiar with a field, such photos might only marginally improve the understanding or knowledge of a research process, assuming peers have similar levels of knowledge of process and method. Yet, with a specific goal such as reproducing the results, reflecting on a project, performing peer reviews, considering malpractice or simply taking inspiration from colleagues, these photos might prove useful.

Researchers who are unfamiliar with the methods and processes of a certain field might learn more from papers with these photos included. Yet, photos contain a lot of information and while the descriptions of these photos might explain the processes generally, researchers unfamiliar with practices from another field might be overwhelmed or not 'get' why a photo contains a significant activity. An example of this was how I personally didn't at first see the significance of the preparation phase photo of the second participant. Only after he had engaged in explaining the method and photo, the significance of his result in the photo 'clicked'.

Could adding these types of photos and descriptions to research papers, help authors to reflect on their research processes and results?

By adding photos and writing descriptions for these photos, researchers have to engage with the photos and the activities they represent actively. In a similar fashion, during the photo-elicitation interviews, the participants engaged in reflecting on their photos extensively. Most of the descriptions and discussions go into why and how they took photos, but participants often also explained the processes behind the depicted research activities and their relevance to their projects. Thus, this process of engaging with these photos creates can facilitate a meaningful reflection which results in a good description or discussion. Thus, simply adding these photos could illustrate a process, but a reflection of the activity might result in a meaningful description that might inform the reader.

These descriptions and discussions varied among participants in reflexiveness and objectivity. The more personally reflexive responses came from the participant with an anthropological background. As a cause of this, she pointed to the convention in anthropology where it is common for researchers to reflect on and include their personal background in their research. The participant from the natural sciences was in contrast more objective during the discussion, mainly explaining the chemical processes and indicating the potential to increase the replicative value of a research project. The latter participant indicated that in the natural sciences, it is not so conventional to reflect personally on research. All participants, regardless of the objective or reflexive nature of their descriptions, however, remarked on the usefulness of these respectively. This indicates that adding photographs to a research paper could help researchers to reflect on their research process if activities like describing or discussing the photos are performed. Additionally, insofar these results show, either an objective or more personal reflection could have potential benefits in varying fields of research.

Could taking, instead of just adding these types of photos, help authors to reflect on their research processes and results?

These limited results point towards photos providing a potential benefit to reflect on a research process if a researcher engages with them by describing them or discussing them in for instance a photo-elicitation interview. By also taking the photos instead of just adding them from an existing body of photos, a researcher has to engage in thinking about what to photograph, how to photograph it and whether or how a researcher himself should be in the photo.

Some photos in these results were taken of retroactively reproduced research activities, as can be identified in the last line of their descriptions, i.e., of researchers imitating their activities from certain phases. The descriptions of participant 3 for example were described more personally than the two he took before. This is similar to participant 2, he also chose a more personal tone to motivate his research activities in these reproduced photos. For the first participant, however, the photos she took earlier during her actual research seem to have been described with a more personal tone.

While these results are inconclusive, they do point towards a difference in description between the photos taken for the purpose of this research and those already taken. This could be due to a variety of variables such as simply remembering an intention behind a photo better, or on the other hand, simply because the participants were instructed in the experiment to clearly set and motivate an intention behind a photo.

Arguably, as earlier indicated, fields like anthropology might value these more reflexive descriptions more than a field in the natural sciences, which might explain the difference.

Does it matter who is in the photo? The author of the respective research, someone else or nobody?

Like the photo of Ingo Älthofer in front of his washing machine, a photo enables transparency of a research process but can also put a face on a research paper. In anthropology and other social sciences, this personal aspect of academic research has been recognised and is often integrated in the communication of this type of research. For instance, in recognising that a researcher integrates and interacts with their environment, which influences their view of the subject they’re studying. (Johnson, 2011)

In the natural sciences, the emphasis generally lies on a more personally removed mode of observation and documentation of natural phenomena. A researcher in these fields is personally less involved in the matter that is studied, as is supported by the style of descriptions of photos of participant 2. His descriptions of research activities seem similarly removed from personal reflection, and instead

emphasise the technical details of the activities. Only the last line of the description indicates a motivation towards including the photo, yet this often feels in sense forced and might be done to simply comply with the experiment of this research. To highlight this, here is an excerpt from the description of the analysis phase:'The masses of the synthesized peptides were confirmed using mass spectrometry on a Shimadzu LC-20AD system with a Shimadzu ShimPack GISS-HP C18 column (3.0 x 150 mm, 3 µm). The picture was taken using a Samsung Galaxy S8 mobile phone. The photo is intended to showcase the instrument used to perform the analysis.'

What I personally found interesting is that the four photos with their respective authors visible in them, (participant 1 and 3 mainly) created a sense of narrative throughout the photos. Seeing the participants perform the research activities in combination with their descriptions garnered a sense of understanding of these processes. Specifically, the activities of preparing an experiment or process of gathering data that are found in the second and third phases. Participants themselves also remarked on this explanatory quality in the interviews.

Further research could shed light on the implications of these hypotheses and explore whether photos without researchers could for instance also bring about a sense of understanding in readers. Additionally, which groups of readers and which fields of academia could be most useful.

5. Discussion

Researchers who in photos of their research process in their research papers could increase the degree of transparency of their research process. This transparency, in varying degrees, might be tied to the engagement of the researcher with the process of taking and describing a photo. A stock photo, for example, would not nearly garner as much insight into the process of research as a photo taken and described by the researcher himself. This transparency could benefit for instance the replicative value of a research paper or help explain research practices like the preparation of experiments or the gathering of research data.

Additionally, the presence of a researcher in these photos may have an effect on the transparency and explanatory potential of these photos. Researchers performing their process in these photos might help to explain these processes, but since current results are insufficient in this area, this needs further investigation.

Furthermore, adding photos and descriptions to a research paper resembles a mode of documentary photography in which, instead of an external photographer, the photos are being taken and described by the authors of the research themselves. This can introduce a degree of personal reflection into the communication of a research project which was highlighted by a participant from the social sciences and somewhat ignored by a participant of the natural sciences. Fields like anthropology apply this personal reflection towards the acknowledgment of their own biases in relation to their research, thereby attempting to communicate their research more transparently, while the participant from the natural sciences kept some distance from this personal reflection. Conventionally, in the natural sciences side of academia, personal aspects of researchers are limited mostly to writing style and author names, which are often shortened to initials. Hence, this begs the question of whether researchers from a broader spectrum of sciences are willing to explore the potential benefits of reflecting on their personal process in similar ways in order to improve the transparency of the communication of their work.

Currently, two of the participants (2 and 3) attempted to include photographs of their research processes in their research papers with the intention to include these in their publications. Yet, their publishers both refused to include these photos. One of such, situated in the natural sciences, stated the reason that photos with no obvious reference in the main text should not be in a paper, while the other gave no reason and simply rejected them.

We can of course still wonder why this happened, was that simply a matter of convention or guidelines of the journal tied to those conventions? Or, do others simply not see the same kind of value of photography and the process of research that I think resides in these?

We could also wonder whether researchers and publishers for that matter want this kind of transparency or have a need for it. However, if we strive for a scientific practice that is objective or in this case free of personal reflection and visible activity, are we not striving for the impossible?

In the history of photography, the first cameras were praised because of their alleged passive, mechanical, and therefore purely objective observations rendered as photographs, free of bias and motivations. But this claim was quickly refuted, and scholars realised that a camera and the photographs it produces are directly influenced by every decision its operator makes. The photographs in these results gain their significance because they're partial and use this personal knowledge of the researcher to point out significant activities and their implications in relation to the research. If we communicate clearly that all of us are affected by personal motivations, biases, cultural differences, and other variables, could we use photography to develop and enrich the communication of research by being more transparent?

Limitations

While this research resulted in insights and interesting questions, the lack of data on applying the method to research projects from their start to finish makes it hard to pin down the benefits of communicating the research process through photos. Additionally, the identified potential benefits of using photos are rooted in the discussions with participants about their results and are explorative in nature. Ultimately, the participants' academic backgrounds and conventions provided valuable angles of approach into exploring the potential of photography to communicate research practice, but due to the limited number of participants, the results and insights are explorative at best and do not represent the potential benefits or detriments that might be found in larger groups of participants.

Further Research

Further research is needed to explore whether the potential benefits of photography identified here hold up when researchers integrate the method into a research project from its start until its publication. Especially the longer time to plan and get used to photography as a means of communicating the research process might influence taking and choosing more fitting photos of the research process. It would be interesting to compare those results to this research, where applying the method was done retroactively, and where participants recreated photos and shorter time to get used to the method. Additionally, when developing the method further, the question arises whether special attention could be given to create a method for researchers to reference other researcher's photos in their papers. Should this be done in similarly to how photos are referenced now, or should a new system be introduced that is more attuned to the reflexive nature of photo and description of a research process?

Furthermore, papers including photos should be subjected to quantitative research among varied groups of readers, from peers with similar knowledge of the field to laypeople, to determine their usefulness regarding the identified benefits in this research. It would also be interesting to look at a question asked earlier in this research, what kind of cognitive effect photographs of the research process could have on remembering research papers. Additionally, the potential to increase the replicability of a study could be tested comparatively to assess the impact of photos of the process of research on the replicative efforts of a research project.

While researchers might try and improve their publications using photographs of their research processes, journals and publishers should be confronted with similar questions if a change in convention is ever to take place. Hopefully, the question of how we might improve the communication of science with peers and public could in the future also take photography and other media into account.

> *What counts as research? What matters as data? What procedures are considered legitimate for the production of knowledge? What forms shape the making of explanations? What constitutes proof? (Daredevil Research Recreating Analytic Practice, Jipson & Paley, 1997)*

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7. Appendix

Appendix 1: The photography method.

Documenting research through photography: a method

If we documented research through photography instead of text if we showed what we did rather than described it, what would academia look like?

Introduction

Every researcher goes through a complicated process of many steps when doing academic research. We can attempt, however, to boil down that process into four general phases: a preliminary research phase, a preparation phase, a work phase, and an analysis phase. These phases generally contain all core activities that constitute a research project. During and after these activities are completed, the research is conventionally documented in a research paper which is written according to conventional templates or standards, most of which are primarily text-based papers. The texts in them represent the research process and activities. However, by only using text we could be excluding valuable information about that research process, the activities in it, and what these looked like. Usually, this form of visual documentation is disregarded, except when photos simply show a result, a wormhole, a part of a flower, or parts of a cell. Yet, it might prove beneficial to document the process of research itself too.

This method serves as an exploration into how photography could be used to document research consistently. A process focussed on systematically being aware of three steps: taking photos during the research process, providing them with a title and systematic description, and integrating these into a paper. As a result, the resulting photos support the text with indexical visual information in addition to textual information. The three steps of the method are inspired by a method of looking at photography through three contexts.

The context of photographs

Words are abstract representations of things and concepts; they carry meaning when the signified is not at hand. Words together, form sentences or utterances, gaining meaning through their context: syntax, grammar, punctuation, formatting, pronunciation, and design. Words have concrete sets of rules that allow them to be sent and sensed in various modalities.

Photographs require context when we want them to carry meaning or deliver a focussed message. We can integrate a photograph into a context by introducing a convention to take and view them. In this method, we consider a combination of three contexts derived from a text by Terry Barrett (1986) on analysing photos: internal, external, and original context. The internal context is all that is evident in a photo. I.e., all we can observe on the two-dimensional grid of pixels we call a photograph, from image quality to the composition of it. The internal context is considered when we take a photo. The external context relates to the photograph's presentational environment; for example, an external photo in a research paper comprises its format, titles, images, and texts. Finally, the original context relates to the photo's making, in this method this context is constructed through a systematic description written by the researcher that took the photo.

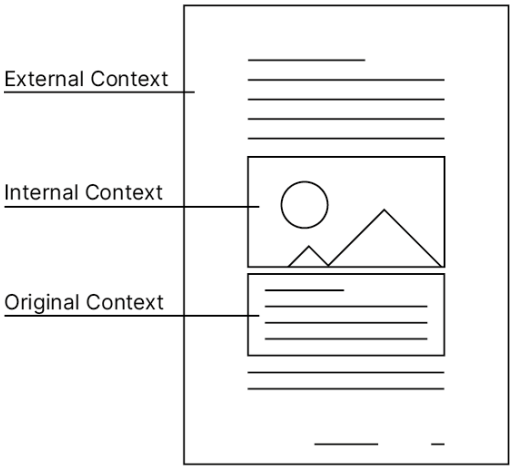


Figure 1. Three types of contexts illustrated

1. Internal Context: Taking photographs

Illustrated below are the four general phases of research we identified earlier, which are put above the scientific method as an example. Ideally, when doing research and following a research method, the phases serve as waymarks as to when to take photos. On the next pages, each of the phases is illustrated through example photographs. Try not to duplicate the example photos, they serve as inspiration. However, a research process of a replication study might result in similar photos.

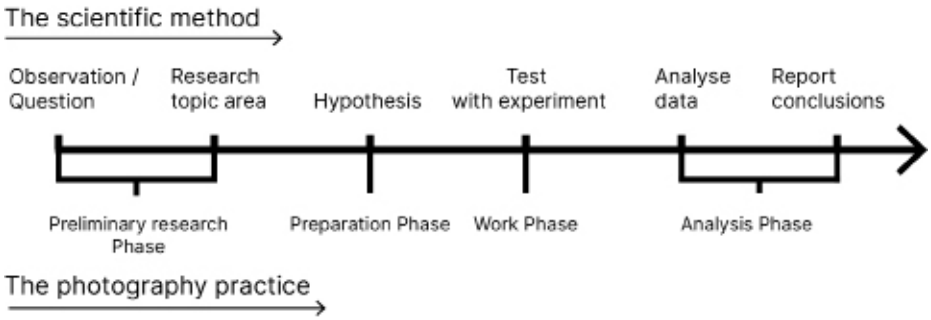


Figure 2. Illustration of the phases and scientific method on a theoretical timeline.

The photos should represent the research activity that represents this phase most genuinely and clearly. If you take more photos consider what the most important moment in that phase was and choose the photo that represents that. Don't pose however, these moments come naturally, it is a good idea to have a colleague or peer photograph the researcher in the moment of an activity uninterrupted. Keep in mind the basic principles of photography when taking photos to ensure proper quality, lighting, and composition. If necessary, refresh or learn the skills in a photography course.

Before taking a photo, ask yourself: 'What activity represtents the phase I am documenting? And how do I do that without fabricating it?'. That will form the internal context of the photo when it is featured in a paper. An example of such a consideration I made is given below.

My work phase should show me (the author) working on my method behind my computer:

Author(s): myself in this example.

The tool(s) used: my camera, computer, software.

The research activity as it's being done: reading, and writing.

A representation of the event that was most important in that phase as it happened. In this case, the creation of this method is crucial to the continuation of this study.

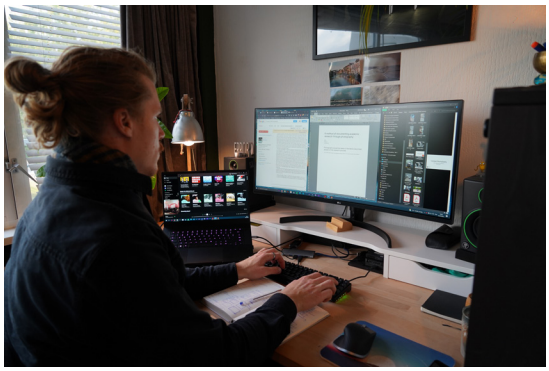


Figure 3. Internal context example 1
The author is sitting behind a computer at his desk in a home setting, with a notebook, keyboard, and mouse at hand. He is reading 'Image-based research' by Jon Prosser (1996) as he outlines the steps of the photography method. He uses Firefox web browser and the text processing program Microsoft Word. A timed shutter on a Sony Alpha 7 III camera on a tripod records the situation. The photo is intended to show the kinds of work in the authors' research process as well as serve as an example photo in this method. Photograph by the author in 2021.

1.1 The preliminary research phase

i.e., Thinking, searching, discussing, reading, noting

A photo should be taken while the preliminary activities for the research project are done. These might take the form of the activities mentioned above.

Figure 3. Preliminary phase example 1
The author and Bob Siegerink walk and discuss the idea of a method using photography rather than text to document science and its potential benefits in an interview during a lunch break in Leiden. The photo is taken by a timed shutter on a camera on a tripod which was put there in advance while the author walked by. The photo is intended to show the kinds of work in the authors' research process as well as serve as an example photo in this method. Photograph by the author in 2021.

Figure 4. Preliminary phase example 2
The author is sitting in his home and reading 'Made to stick' by Chip and Dan Heath on a tablet to prepare for generating a simple research question during the preliminary research phase of this research. A camera was given to the author's roommate and was asked to take a photo while he studied. The photo is intended to show the kinds of work in the authors' research process as well as serve as an example photo in this method. Photograph by the author in 2021.

1.2 The preparation phase

I.e., Planning, hypothesising, preparing for the work

A photo should be taken while preparations for the work phase take place; an excavation planned, a model programmed, pipets cleaned, etc.

Figure 5. Preparation phase example 1
'Soil scientists in the Amazon are gathered around a table in the little restaurant where they house their equipment. They discuss an aerial photograph and a satellite map of this tiny portion of the Amazon to which their expedition is heading.' The photo is intended to show the preparation phase of research through existing photographs taken from Bruno Latour. Photograph and description from Latour, 1998.

Figure 6. Preparation phase example 2
A computer and peripherals sit on the author's desk while a camera is positioned to record the author while working. The author himself uses the camera on his phone to photograph the setup. The photo is intended to show the kinds of work in the authors' research process as well as serve as an example photo in this method. Photograph by the author, 2021.

Photograph 4: A BIOASSAY: THE PREPARATORY STAGE

Figure 7. Preparation phase example 3
'Two young women handling some rats. The woman on the left is injecting a liquid with a syringe and withdrawing another liquid with another syringe which she then passes on to the other woman; the second woman then empties the syringe into a tube.' This photo and quote were taken out of Laboratory Life by Bruno Latour in which he takes an anthropological perspective in research on the research process and research(ers) in a lab. This photo is intended to show the preparatory stage for a bioassay in a lab setting. The above quote and photograph are taken from Latour, 1986.

1.3 The work phase

I.e., Doing the work, writing, testing, questionnaire collecting

A photograph should be taken while the work, whatever form, is done; text written (Figure 8.), material collected (Figure 9.), questionnaires filled or LEGO washed (figure 10.).

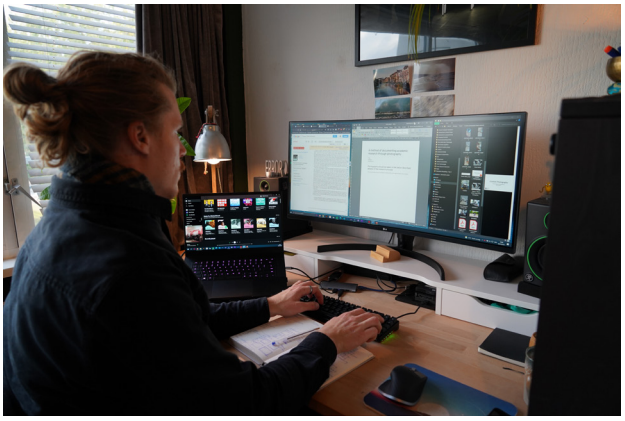


Figure 8. Work phase example 1
The author is sitting behind his computer at his desk in a home setting. He is listening to music and reading 'Image-based research' by Jon Prosser (1996) as he outlines the photography method you are currently reading. A camera with a timed shutter on a tripod records the situation. The photo is intended to show the kinds of work in the authors' research process as well as serve as an example photo in this method. Photograph by the author in 2021.

Figure 9. Work phase example 2
Ecologist Aafke Oldenbeuving is collecting figs and reproductive organs from fig trees in a tropical rainforest. Fig wasp larvae and figs are scrutinised to gain an understanding of how fig wasps find specific fig types and how they have evolved to live mutualistically. The photo is taken from the Naturalis website and is intended to serve as an example and show the variation in types of work in different fields in the work phase of research. Photograph from https://www.naturalis.nl/aafke-oldenbeuving, 2021.

Figure 10. Work phase example 3
Mathematician Ingo Älthofer observes his experiment involving LEGO bricks inside a washing machine. Random complexes are formed throughout a washing cycle in which a washing machine manipulates the LEGO bricks in a similar fashion to an 'analog monte carlo agent simulation technique'. The photo is taken from Älthofer's paper (2013) and is intended to serve as an example and show the variation in types of work in different fields in the work phase of research.

1.4 The analysis phase

I.e., Analysing, describing, discussing, concluding the work

A photograph should be taken while the results of the work are analysed and concluded; substances analysed through spectrometry, text analysed through a framework

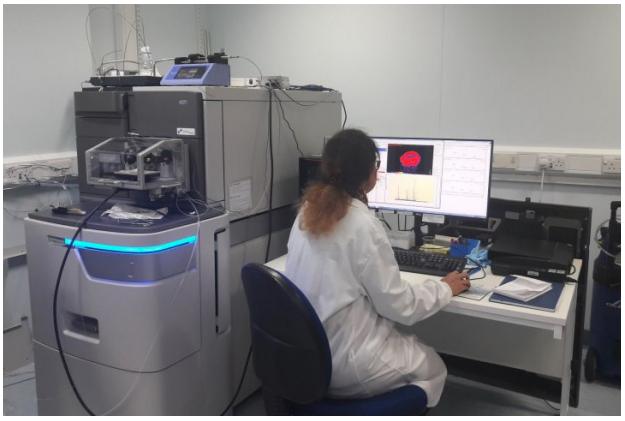


Figure 10. Analysis phase example 1
Researcher Ruth Andrew is sitting behind a mass spectrometry apparatus to analyse hormones in the blood. 'For hormone analysis, for example, this means there is less likelihood that other components in the blood can artificially raise the results.' The photo is intended to show the kinds of work possible in the analysis phase of the research process as well as serve as an example photo in this method. Photograph from https://healthcare-in-europe.com/en/news/mass-spec-needs-experienced-operators.html

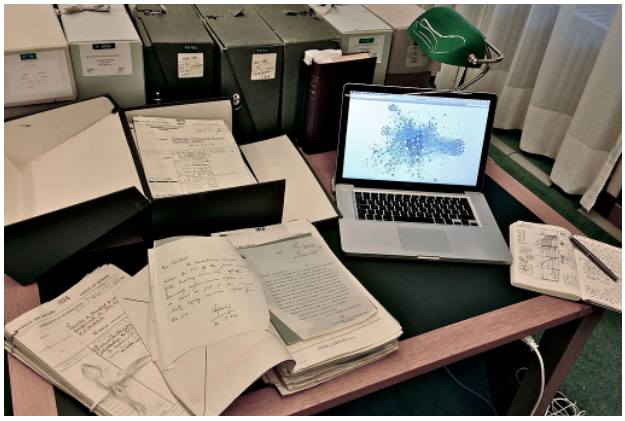
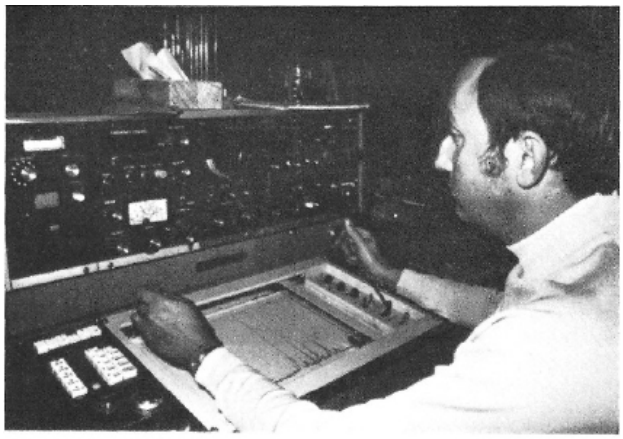


Figure 11. Analysis phase example 2
A desk of a researcher showing analog records and a laptop with visualisation software. The researcher is working in the field of digital humanities analysing an archive of a large organisation using visualisation to explore the network. The photo is intended as an example of how to show the work in the analysis phase of research. Photograph from https://en.wikipedia.org/wiki/Humanities#/media/File:Humanit%C3%A9s_Num%C3%A9riques.JPGJPG



Photograph 8: THE NUCLEAR MAGNETIC RESONANCE SPECTROMETER

Figure 12. Analysis phase example 3
'The whole series of transformations, between the rats from which samples are initially extracted and the curve which finally apears in publication, involves an enormous quantity of sophisticated apparatus (Photograph 8). By contrast with the expense and bulk of this apparatus, the end product is no more than a curve, a diagram, or a table of figures written on a frail sheet of paper.' This photo and quote are intended to show a research activity in the analysis phase in laboratory research, as well as the analytical value of that same photo in the context of anthropological research into the process of research. The above quote and photograph are taken from Latour, 1986.

2. Original Context: Putting the photo into words

The original context translates the intention of the author behind both taking and including a photo in a certain phase into a description. That description is written systematically and suggests to a viewer what has value and is relevant to the research process the photo is featured in.

A functional description of a photograph placed in a paper should describe in the words of the photographer what was done and what is seen as well as why this photo was included to represent the respective phase in the research process. This ensures the photo gains a sense of genuine representation of what is done instead of becoming an illustration of how the research could have been done which leads to inaccuracy.

in the grey box to the right, an example description is given. Below, an instruction for writing such a description is given in steps.

1. Index the photo with 'Figure' and a number for later reference.
2. Provide a title that summarises what a reader is looking at.

   Then a description follows:
3. Objectively describe what can be seen in the photo (internal context) in the first sentence using your knowledge as an author/researcher. (1).
4. Describe what is done in the photo using your knowledge as an author/ researcher in the second sentence. (2).
5. A third sentence informs about the relevant tools that are used in the phase of the research process (3).
6. A fourth sentence informs the reader about the intention behind it, the photographer or writes this (4).

* If a photograph is used from another research paper, it is useful to feature a quote describing that photo to retain the intention behind it. This is also done with examples in Figures 5, 7,

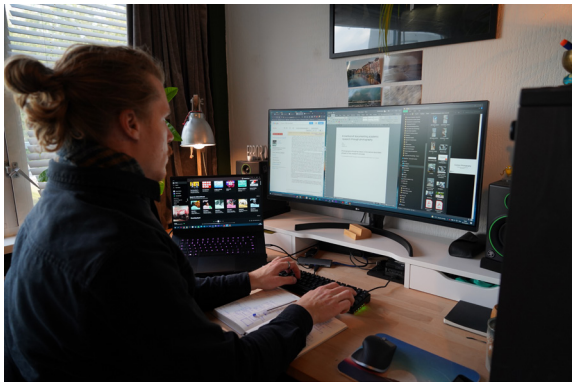


Figure 7. Work phase example 1

The author is sitting behind a computer at his desk in a home setting with a notebook, keyboard and mouse at hand (**1**). He is reading 'Image-based research' by Jon Prosser (1996) as he outlines the steps of the photography method (**2**). He uses Firefox web browser and the text processing program Microsoft Word. A timed shutter on a Sony Alpha 7 III camera on a tripod records the situation (**3**). The photo is intended to show the kinds of work in the authors' research process as well as serve as an example photo in this method (**4**). Photograph by the author in 2021.

3. External Context: Putting it all together

An external context is comprised of the presentational environment that surrounds a photograph (Barrett, 1986), the organisation of content and text around it, the title and caption, and ‘in a more abstract but no less informative way, even the very name of the journal which represents a knowledge can heavily orientate the reading of the message’. (Barthes, 1977)

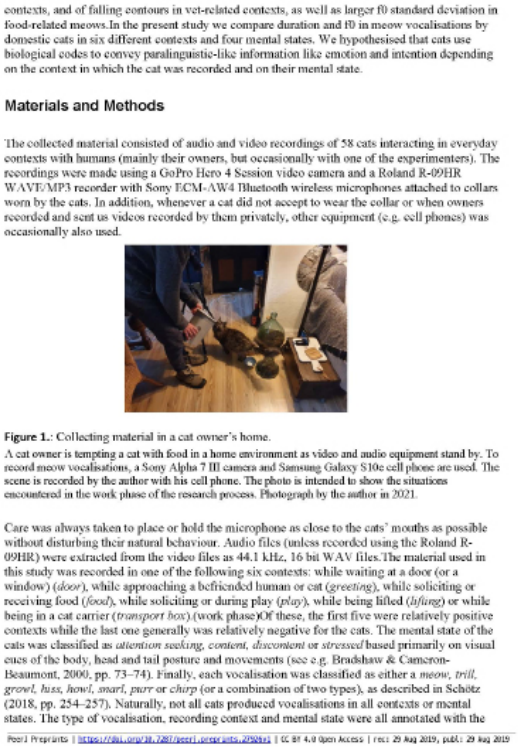
By keeping this in mind while taking, describing, and inserting photographs we can attempt to document the activities in the research process through photography. The external context, which is constructed when we ‘design’ or put together a paper is the final step in that process of documentation.

Constructing the external context

When formatting the research, it is most important for the photo to be close to the text in which the research activity is mentioned and give it space you would normally do for a figure. The title and description can then simply be placed underneath the photo depending on the requirements and restrictions of the journal it is published in.

The placement of the photo in the paper can differ as mentioned earlier. As is shown in the example here, photos of the research process are featured integrated into the text, in this case, the ‘work phase’ photo is featured in the ‘materials and methods’ section. Figure 2. might serve as inspiration as to in which chapters the photos from the phases can be integrated most intuitively.

Some journals will require the photos to be put on a separate (final) page, it is important then to have the descriptions featured there as well to maintain the coherence of the research process.



contexts, and of falling contours in vet-related contexts, as well as larger f0 standard deviation in food-related meows.In the present study we compare duration and f0 in meow vocalisations by domestic cats in six different contexts and four mental states. We hypothesised that cats use biological codes to convey paralinguistic-like information like emotion and intention depending on the context in which the cat was recorded and on their mental state.

Materials and Methods

The collected material consisted of audio and video recordings of 58 cats interacting in everyday contexts with humans (mainly their owners, but occasionally with one of the experimenters). The recordings were made using a GoPro Hero 4 Session video camera and a Roland R-09HR WAVE/MP3 recorder with Sony ECM-AW4 Bluetooth wireless microphones attached to collars worn by the cats. In addition, whenever a cat did not accept to wear the collar or when owners recorded and sent us videos recorded by them privately, other equipment (e.g. cell phones) was occasionally also used.

Figure 1.: Collecting material in a cat owner’s home.
A cat owner is tempting a cat with food in a home environment as video and audio equipment stand by. To record meow vocalisations, a Sony Alpha 7 III camera and Samsung Galaxy S10e cell phone are used. The scene is recorded by the author with his cell phone. The photo is intended to show the situations encountered in the work phase of the research process. Photograph by the author in 2021.

Care was always taken to place or hold the microphone as close to the cats’ mouths as possible without disturbing their natural behaviour. Audio files (unless recorded using the Roland R-09HR) were extracted from the video files as 44.1 kHz, 16 bit WAV files.The material used in this study was recorded in one of the following six contexts: while waiting at a door (or a window) (*door*), while approaching a befriended human or cat (*greeting*), while soliciting or receiving food (*food*), while soliciting or during play (*play*), while being lifted (*lifting*) or while being in a cat carrier (*transport box*).(work phase)Of these, the first five were relatively positive contexts while the last one generally was relatively negative for the cats. The mental state of the cats was classified as *attention seeking, content, discontent* or *stressed* based primarily on visual cues of the body, head and tail posture and movements (see e.g. Bradshaw & Cameron-Beaumont, 2000, pp. 73–74). Finally, each vocalisation was classified as either a *meow, trill, growl, hiss, howl, snarl, purr* or *chirp* (or a combination of two types), as described in Schötz (2018, pp. 254–257). Naturally, not all cats produced vocalisations in all contexts or mental states. The type of vocalisation, recording context and mental state were all annotated with the

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Figure 13. A page in a paper in which a photo and description were added according to this method.

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Appendix 2: Photo elicitation interview questions

Photo Elicitation Interview

Participant

Date

1. **Their research – Show nothing**

    a. Can you explain in a few sentences what the research you photographed is about?

2. **Per phase – Show only photo.**

Preliminary phase

a. What does this picture show?
b. Why did you take this photo?
c. Were there photos you wished you had taken of this phase but didn't? If so, why not?

Setup phase

a. What does this picture show?
a. Why did you take this photo?
a. Were there photos you wished you had taken of this phase but didn't? If so, why not?

Work phase

a. What does this picture show?
b. Why did you take this photo?
c. Were there photos you wished you had taken of this phase but didn't? If so, why not?

Analysis phase

a. What does this picture show?
b. Why did you take this photo?
c. Were there photos you wished you had taken of this phase but didn't? If so, why not?

3. **Overall – descriptions**

    a. Did writing the descriptions feel useful to you? Why?

4. **This research – concluding**

    a. Do you think your research can benefit from photos added according to this method? Why?
    b. Is there other research you might've read that you would've liked this method to have been applied to?

5. Further research

a. Do you feel there is any information or value in these photos that is not otherwise included in the research paper? Is that important?

b. How was your experience working with the method further, did it make you look at things differently? It's fine if it didn't.