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Communicating with non-humans: a new visual language

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Communicating with non-humans: a new visual language

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Table of contents

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Editorial: Communicating with non-humans: a new visual language

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Editorial on the Research Topic
Communicating with non-humans: a new visual language

> *"Our failure to situate dominant forms of human society ecologically is matched by our failure to situate non-humans ethically"* (Plumwood, 2001, p. 2).

New visual communication platforms have profoundly altered the visual tools of pedagogy and exhibition communication, targeting the way(s) we envisage and shape our futures (Mitchell, 2008; Mirzoeff, 2015). However, in the 21st century, visual communication is still dominated by human-centered views about exchanging information intended for, and that often drives, human consumption (Borthwick et al., 2022). However, visual communication also embraces new genres of imaging, including multi- and hypermedia, non-human biological actors, augmented and virtual reality, and, ultimately, artificial intelligence. In communicating visually, rich formats and (re)presentations can support human participatory experiences with non-humans by using visual media in various spaces for coexistence (Bennett, 2010).

Non-human agency and visual communication with non-humans opens possibilities for shared authorship as it can provide the means to generate contact with those whose means of meaning-making are unknown to humans (Bennett, 2010; Barad, 2007). In this context, bioart and biodesign, new areas of practice and research that can manipulate life processes (Kac, 2007), are innovative in exploring nature as a source of creative encounters between humans and non-humans, evoking pre-mechanical and pre-digital forms of communication. This kind of duality illustrates the tension between tradition and innovation in visual communication practices.

Contributions to this Research Topic revealed, in written and visual form, a wide range of successful (or failed) co-authorships between artists, art educators, and non-humans. The articles discuss processes, outcomes, practices and collaborations in the nexus of human and non-human. Makers, artists, designers, and researchers presented multifaceted explorations in studios, laboratories, or residencies, working between fields and disciplines with non-humans. The eight articles in this Research Topic explore the following questions:

- How can 21st-century visual technologies, indigenous critiques, and ethical co-authorship explore post-humanist creativity in visual communication?
- How can participation in visual communication enhance practice-based and contextual plurality between humans and non-humans?
- How can education through visual arts and design facilitate understanding to improve human–non-human communication?
- How can themes such as visual relationality, post-human collaboration, ethical reflexivity, material-technology interplay, and adaptive coexistence offer narratives for disseminating insights across design, art, and ecological sustainability?
- How can participatory experiences between humans and non-humans be visually communicated, and what roles do digital technologies play? How can collaborations with non-humans be revealed and understood using digital technologies?

The ethical implications of indigenous ontologies and non-human agency are recognized in the new materialist philosophy of science and indigenous scholarship (Watts, 2013; Whyte, 2018). These frameworks advocate for ethical recognition beyond colonialist paradigms to critique the role of humans as key decision-makers with dire implications for non-humans—whether embodied in a river, forest, or microbial community (Escobar, 2018; Tsing, 2015). Indigenous scholarship and new materialist philosophy emphasize the interconnectedness of humans and non-humans, urging a rethinking of ethical frameworks in visual communication.

Beyond anthropocentrism, bioart and biodesign can be innovative mediators of human and non-human interaction represented as visual representations and facilitated by mechanical and digital technologies (Kac, 2007; Mitchell, 2015). The proliferation of visual exchange brings contradictions. While it democratizes representation, it also risks amplifying (dis)information and often reinforces patterns of human-centered consumption (Haraway, 2017). This tension highlights the need for critical engagement with visual communication's ethical and philosophical dimensions, particularly concerning non-human agency.

Four rudimentary themes emerged from this volume's eight articles: visual communication, collaborative co-creation, ethical reflexivity and de-centering of anthropocentric hegemony. These themes contest the dominant norms of traditional human-centered paradigms; they rely on inclusive, relational and materially embedded creativity, research, and societal engagement. The eight articles touch on, to different extents, on the following themes:

Visual communication can be a catalyst for mediating understanding of non-human relationships and interactions

The role of visual mapping and representation in mediating complex relationships between humans and more-than-human (MTH) actors is introduced by Zohar et al. in their article titled "*When we talk about time, we mean many different things: employing visual mapping to think through more-than-human temporalities in participatory design*." In their article, participatory visual mapping emerges as a dynamic tool for navigating temporal and spatial dimensions of MTH interactions. Abstract concepts like time, for example, spanning "near lens" individual experiences to "far lens" ecological timescales, foster awareness of interconnected temporalities and relational agency in visual communication.

Similarly, the article by Karhu et al. titled "*Understanding animal-oriented social media collaboration in Australia's 2019–20 bushfire crisis*" illustrates collaboration on social media during an Australian bushfire crisis. The collaboration mobilized human action by mediating human-to-non-human understanding by leveraging visual depictions of suffering wildlife. The article reveals how non-human trauma can catalyze human solidarity amid an ecological crisis. This case underscored the necessity of frameworks that balance human accountability and contributions toward care for non-humans through human co-creative craft-making acts fuelled by social media interaction.

Visual communication for co-creation and post-humanist collaboration

The articles collectively reframe creativity as a collaborative process involving human and non-human actors. The article by Griniuk titled "*Post-humanist artistic research by the production of performance and Techno-Lab workshops in Sapmi*" discusses post-humanist artistic research and AI transitions from a passive tool to an active, creative assistant that can inspire artistic creation and research through dynamic, improvisatory exchanges.

This shift mirrors bioartistic collaborations with bacteria or reindeer blood, where material agency—such as bacterial luminescence or blood's pigment properties—shapes artistic outcomes. In Saeki et al.'s article, "*The (im) possibility of communication with non-human beings: with digital screen printing of luminous bacteria*," the authors challenge the anthropocentric views of communication and technology by introducing biological non-human agency into traditional media forms. Their article uses luminous bacteria in digital screen printing to interrogate anthropocentric media histories.

In the article by Pietarinen and Qureshi titled "*Blurring bioart boundaries*," the authors draw from ancient traditions of mark-making using blood as a pigment. The authors introduce new explorations and innovative art forms using reindeer blood to acknowledge humans as not separate from but co-evolving with other life forms. Such practices demand a reconfiguration of authorship, ethics, and intentionality, alongside the cultural implications of using life-giving materiality like reindeer blood.

FIGURE 1
Sunflower seedlings create a wool tapestry in the BioARTech laboratory of the University of Lapland, Finland (2022). Artists: Sunflower Seedlings and Melanie Sarantou. Materials: wool. Photography by Melanie Sarantou.

Visual communication can stimulate ethical and critical reflexivity

Ethical considerations permeate discussions of materiality, technology, and representation. For example, using reindeer blood in art prompts reflections on interspecies ethics, advocating for practices that honor ecological sustainability. In addition, the article by Raappana-Luiro, "*Miracle of nature—dialogue with nature through artistic creation*," discussed how historical visual styles linked to colonial natural history illustrations can recontextualize contemporary art to critique human exploitation of the environment while fostering wonder for biodiversity.

Miettinen and Sarantou's article "*Visual communication through performance collaborations*" proposes a critical framework based on respectful improvisation and material sensitivity with placemaking. The article underlines the essential role of context-sensitive and iterative practices deterring anthropocentric presumptions through artistic performance and cooperation with non-humans in attentive ecological practices (Figure 1). Critical reflection on human boundaries and limits of natural resources might stimulate improvisatory and symbiotic sustainable visual communication praxis.

Materiality and technology can act as mediators in visual communication

The interplay of materiality and digital technologies surfaces as a key theme. Bioartistic works are anchored in organic materials such as bacteria, blood, glass, wool fibers and sunflower roots, alongside digital media to blur boundaries between living and non-living, organic, and synthetic expressions. These material visual transformations challenge the hierarchy of human over non-human, suggesting that creativity arises from entanglements.

The article by Zhao, "*The creative cosmos beyond humans: a symphony of participatory design and visual artificial intelligence*," reveals that AI agents, whether viewed as mere tools or creative partners, significantly influence creative performance. Visual tools in participatory design demonstrate how technology can mediate human-MTH interactions. Similarly, Karhu et al. illustrated that digital platforms can mobilize participatory experiences beyond physical and species boundaries. Hybrid practices are required for these forms of technology, but since they inherently reinforce human proficiencies. Critical and reflective practices need to be employed to prevent dominant humancentric foci.

Conclusion

In conclusion, integrating the themes of this series of articles has implications for practice and research through a transformative agenda for visualization design, art, and education. For example, curricula must integrate digital, ecological, and ethical literacies by developing pedagogies for multispecies literacy, emphasizing critical reflection on AI, authorship, and material ethics. Courses could explore how visual arts facilitate human–non-human communication, using case studies from bioart or indigenous practices. By reimagining post-human participatory models, stakeholders can engage with non-human agents through AI-mediated co-creation, bioart, or community-driven conservation projects. Tools such as visual mapping can help navigate power imbalances and amplify marginalized voices. At the same time, a critical framework (Miettinen and Sarantou, this publication) aims to enhance practices for visually communicating with and through MTHs. Future research should continue to focus on the role of digital technologies in documenting and respecting non-human authorship and how failed co-creations can inform ethical guidelines for interspecies collaboration. By centering reciprocity, adaptability, and ethical reflexivity, this work illustrates how creative and societal practices can honor the vitality of all planetary actors and challenge the visual reimagination of humans' roles as respectful participants in more-than-human worlds.

Author contributions

MS: Project administration, Formal analysis, Writing – review & editing, Writing – original draft, Conceptualization. AK: Writing – review & editing, Writing – original draft, Conceptualization. SM: Conceptualization, Funding acquisition, Resources, Writing – original draft, Writing – review & editing. HP: Writing – review & editing, Writing – original draft, Conceptualization.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Miracle of nature—dialog with nature through artistic creation

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The aim of this study is to analyze the effect of an illustrator's visual style in representing nature. The focus is on the author's own artistic project in which the personal relationship with nature is reflected. As for theory, the style used in the representation is seen as a combination of semiotic resources. In this case, the style is inspired by historical images: old still life paintings and illustrations from natural encyclopedias and field guides. The stylistic influences work as a connotative semiotic resource. From a wider perspective, how we represent nature creates social discourses of nature and our attitudes toward it. The results indicate that fact-based communication of nature would also benefit from the emotional effect of esthetic imagery.

KEYWORDS

cultural connotation, illustration, personal style, visual style, stylistic conventions, social semiotics, nature, natural history

1 Introduction

The aim of this arts-based study is to analyze the effect of the visual style when representing nature. The focus is on my own art project where my personal relationship with nature is reflected. Theoretically, this article applies the concepts of visual style and cultural connotation used in the field of social semiotics. According to Theo van Leeuwen (2005, 26), the main interests in social semiotic research concern semiotic resources, their history and the ways they are used and developed in certain social and cultural context. As for semiotic resources, they have the potential for meaning making based on connotations with their past uses. Typical for cultural connotations is that they often convey ideas and values, rather than any specific people or places van Leeuwen (2005, 274). In the context of this study and my own works, a visual style is seen as a resource of meaning making, and especially the stylistic connotations as a crucial way of creating an overall atmosphere and meanings.

The works that served as material for this study (Figures 1–3) were created for a group exhibition of graphic designers called The End of the World (2023). My three works form a whole where I reflect my feelings about the end of the world in terms of nature. As a graphic designer, feeling somewhat foreign to the art world, I prefer to identify myself as an illustrator making pictures for everyday use. In other words, in this particular case, I hovered between the fields of applied and fine art for the context and my sources of inspiration. After all, the context of fine art offered me freedom to express my personal lifelong devotion to nature. My own relationship with nature is based on my early childhood experiences of nature as a miracle. This experience has later developed into a mental-visual reserve, combined with the images of the surrounding culture. In my childhood memories, fantastic texts and images of my grandfather's natural encyclopedias from the early 20th century and illustrations of the old field guides of birds and insects merge with my experiences of wandering and exploring in real nature. During the study, I discovered that past representations of nature that were etched in my mind were just focused on the idea of nature as a miracle.

FIGURE 1
Raappana-Luiro. 2023. *The Ark*. Scanography.

As a technique of my works, I used scanography, which I have versioned in commissioned illustration works in recent years (Raappana-Luiro, 2021). This technique, which I use by scanning natural objects and then manipulating images in PhotoShop, has potential to a special kind of visual style: The lighting created by a desktop scanner is not similar to what we have used to see in photographs. Also, the depth of field is different, giving the images the almost surreal precision of details. This "magical realism" creates stylistic connotations with my personal favorites: Still lifes from the Dutch Golden age and old natural history illustrations, including those made by biologist and illustrator Ernst Haeckel in the 1800-tale. In this essay, the way in which these stylistic connotations affect the meanings aroused in a contemporary artistic context—a semiotic change (see Aiello and Van Leeuwen, 2023, 41; van Leeuwen, 2005, 26)—is examined.

A social semiotic view of meaning making takes the meanings as unstable, reflecting broader social and cultural changes. Aiello and van Leeuwen (2023, 28) stress the importance of "…an approach which considers history and the historicization of meaning-making as the core components of all social semiotic endeavours." By studying the history of semiotic resources—the past of contemporary contexts—and the values attached to them, it is possible to understand "how and why these resources came to be the way they are" (Aiello and van Leeuwen, 2023). Cultural connotations—or provenances, which term Kress and van Leeuwen also use –- is a way of creating meanings by reminding the viewer of some previous context in a new context, in which the semiotic resource has not been seen earlier. Provenances affect our interpretations of not only images but also more broadly of surrounding visual-material culture, such as fashion or interior décor (Kress and van Leeuwen, 2021, 250–251; Aiello and Van Leeuwen, 2023). The aforementioned potential of connotations to convey ideas and values is well suited to conveying the spirit of the historical era. When using historical style connotations for meaning making, it is also reasonable to make a short dive into the cultural history of representations of the nature as a miracle.

2 Nature as a miracle—historical sources of theme

Cultural connotations to earlier visual representations are like an infinite series of translucent layers of visual conventions, all of which offer semiotic potential for meaning making. Concerning the communicative use of historical styles, it is hard to use the semiotic potential of styles intentionally because of this layered infinity. Nodelman (1990, 64) notes, that "[b]ecause styles speak so strongly of the values of those who originated them, illustrators who borrow them may even evoke ideas and attitudes of which they are not themselves consciously aware" (see also Raappana-Luiro, 2022). The basis for my works were my personal experiences of nature as a wonder. Via the

FIGURE 2
Raappana-Luiro. 2023. *Exitus (Spinus spinus)*. Scanography.

stylistic connotations to earlier representations of nature, the works convey the history of the ideas of nature as a miracle, thus participating in construing the whole theme of the pictures.

The organic relation of nature and culture in earlier periods grew to change at the threshold of the Early Modern Era. In the Late Medieval culture, nature began to be seen as the materialization of some cosmic power, as a miracle (Olalquiaga, 1988, 210–236; Stein, 2021). At the same time, the objects of nature gained a new, transcendental layer of meaning: Churches began to add miracles of nature—ostrich eggs, narwhal tusks and even man-made creatures constructed of parts of real nature or animals—side-by-side with relics (Olalquiaga, 1988, 210–236; Stein, 2021). The objects of nature became objects of culture with a transcendental aura (Olalquiaga, 1988, 210–236; Stein, 2021).

Natural history as a science developed in the interaction between renaissance artists, naturalists, and collectors, who shared a prevailing interest in describing, classifying, and collecting natural objects (Ogilvie, 2006, 13; Neri, 2011). Cabinets of nature curiosities were representations of this interest. They were sites of "contemplation, experimentation and study" (Geczy, 2019, 28). At the end of the seventeenth century, the culture of possessing, ordering, and observing objects came to a climax in Holland, and the concurrent genre of still life painting is seen as a parallel to cabinets of curiosities (Honig, 1998; Geczy, 2019, 26). The conventions of visual representation developed hand in hand with the culture of collecting and ordering things. In natural history, encyclopedias, still lifes, and cabinets of curiosities, combined a scientific standpoint with esthetic aims. Nature began to be represented as a collection of classified miraculous objects isolated from their natural surroundings (Neri, 2011, xii–xiii). This kind of "specimen logic" connected the visual style of the images and their purpose of classification (Neri, 2011). A widely influential example of the carefully detailed depiction of a specimen on an empty white background is Albert Dürer's picture of a stag beetle in 1505 (Neri, 2011).

In all the cases mentioned above, objects of nature were seen through layers of cultural meanings. In medieval Christian miracles and Renaissance marvels, representations of nature were loaded with fantasy and esthetics until the earlier miracles were gradually given only an allegoric meaning: the attitude toward nature was shifting from the mystical to the rational (Olalquiaga, 1988, pp. 230–23). After all, there are still many nuances of the miraculous essence of nature even in 19th century nature philosophy and its visual representations. Romantic thinkers and biologists shared the idea of a connection between science and art: esthetic comprehension was considered equal to scientific understanding about the organic whole of nature (Richards, 2002, 12). Darwin (1859), as a committed adversary of any miraculous view of nature, uses words like "wonderful" and "beauty" numerous times in his *On the Origins of Species*. Using a similar literary style, Haeckel (1904), one of my stylistic sources of inspiration, entitled his book *Kunstformen der Natur* conveying the zeitgeist of the Romantic Era.

FIGURE 3
Raappana-Luiro. 2023. *Seed*. Scanography.

For Haeckel, as a Darwinist and adversary to the Christian doctrine of creationism, the wonder appeared in the everyday examination of life, and divinity was manifested in nature itself: in its beauty and order, where there could be found similar repeating structures in all creatures (Halpern and Rogers, 2013; Bauman, 2018). Haeckel's illustrations, especially those presenting the world of submarine creatures, work as visual arguments about his theoretical thinking (Halpern and Rogers, 2013; Bauman, 2018). At first glance, they seem to be very naturalistic in their style. However, the miraculous in Haeckel's depictions is in their absolute symmetry, precision, and detail. Additionally, as for the colored plates (Figure 4), the colors are almost unnatural in their deliciousness. It is easy to understand the popularity of Haeckel's illustrations, especially as marine biology was quite a new field of biology at that time and the submarine world was still unknown both for Haeckel as a biologist and for the wider audience (Halpern and Rogers, 2013; Bauman, 2018).

In the 19th century, there prevailed a common interest in natural sciences also in the popular field of culture (Jovanovic-Kruspel, 2019). Rising urbanism, industrialization, and a wealthy middle class created a need for natural history museums, their nature dioramas being inherited from earlier cabinets of curiosities. The developments of printing methods made the mass production of images possible and numerous field guides and encyclopedias were published for new markets created by amateur naturalists. Illustrations made by skilled professional artists were reproduced or copied in books, on school wallcharts, and in collectible pictures hung on the walls of bourgeois homes. All these representations of natural history formed a kind of mass media of science, which was produced and consumed for didactic, popular scientific, and esthetic purposes (Jovanovic-Kruspel, 2019). This widely used popular imagery was then etched into the collective visual memory (Jovanovic-Kruspel, 2019). I found the copies of these images, including some Haeckel's enthralling picture plates, also in my grandfather's encyclopedias. Consequently, the discourse of the 19th popular natural history became part of my own mental-visual reserve through these books published in the early 20th century.

Nostalgia has become one of the contemporary megatrends. Some time ago I get a sample of printing paper, where there was printed an old watercolor illustration of a beetle on the white background. Luckily also my colleagues got their samples too, and soon they were hanging on our office walls. Many people are nowadays collecting old natural history wall charts and herbaria to decorate their homes. Maybe we long for the past times, where science looked nature with eyes of an skilled artist and nature was full of mystery and wonders – and maybe the whole theme of nature as miracle has its roots exactly in an esthetic experience.

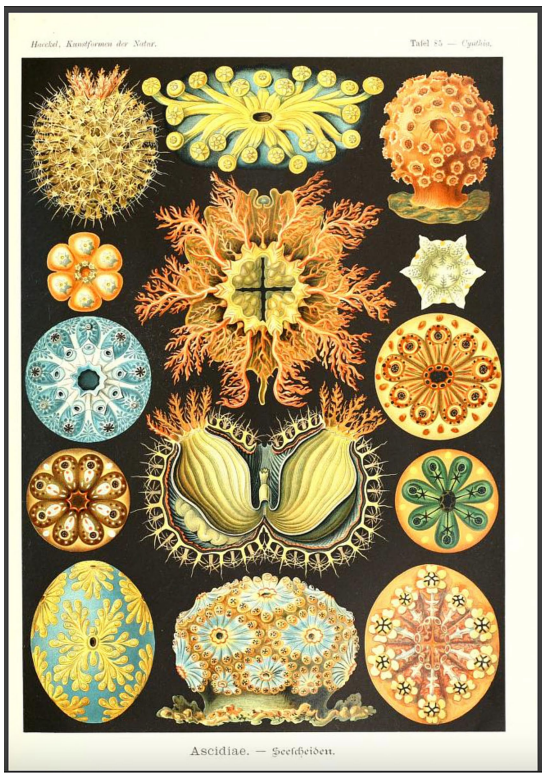

FIGURE 4
Ernst Haeckel. 1905. *Ascidiae. Kunstformen der Natur, plate 85* (https://www.biodiversitylibrary.org/page/33543656).

3 Visual style as a semiotic resource

There are not so many descriptions concerning the concept of style in social semiotic research focused on visual communication. The one reason for this is, that social semiotics has concentrated more on the concepts of discourse and genre. The idea of style as an umbrella concept, including the genre and discourse, offers a holistic view of style as a semiotic resource with a symbolic power (van Leeuwen, 2005, 139). Of particular interest is Meier's (2014) visual model, which, as it were, brings together all the processes and factors that influence the formation of a visual style (Figure 5). The visual style used in representation can be seen as a combination of resources (like colors, composition, materials used, and objects presented) in a certain field of operation (Meier, 2014, 22): for instance the science, marketing, or fine art. Thus, in the semiotic practice, the stylistic choices of made by the image maker are based on the discursive conventions of the context, function, and genre of the image (Meier, 2014, 21–27). As for the audience, the viewers make their interpretation of a picture on the grounds of similar presumptions.

The holistic view of style makes possible to see a style as the wholeness of a single representation. This is reasonable when thinking about multimodal representations, where all the semiotic resources interact in creating intertwined meanings (Siefkes and Arielli, 2018; 163, 28–29). Multimodal presentations often refer to a film or a comic book, for example, but even a single image is multimodal when combining resources such as materiality, technique, color and composition. In my own works, also a resource of language proved to be a way, that limits the sphere of interpretation of the whole. Perry Nodelman (1990, 37) characterizes style as the overall quality or atmosphere that is immediately interpreted by the viewers. We can also interpret some representations as historical or modern almost in the blink of an eye, as we experience some pictures as melancholic or joyful, in a visual minor or a visual major. Style as overall quality is clearly illustrated in the way the still life paintings of Dutch realism manifest their meaning as vanitases, representations of "nature morte." A certain sense of melancholy can be immediately felt in them, even in the paintings without explicit symbols such as human skulls and hourglasses.

In the concrete process of the image making, which Meier (2014) calls a style practice, the designer or artist makes the choices of a theme, content, materials and technique. Then, by using resources of design and composition—the way, how something is depicted—the representation itself is concretized into an image, expressing the personal fingerprint of the image maker. In the context of my own works, the personal style become manifested especially in the way I use the technique of scanography in design. Concerning the connotative resource of style, it seems that the holistic idea of style as multimodal, and meanings as intertwined, is relevant. In my memories of my grandfather's nature encyclopedias, the overall stylistic effect originates both by a text and images, probably including the whole media of the old book with its materials like leathered spin with golden titles and decorations and transparent tissue guards on the pages with pictures. This multisensory nature of experience of style is likely to create atmospheric connotations. For that reason, I did not want to present my works on screen, or on a synthetic, 'plastic' paper, but used the resources of materiality of ink and matte art paper as medium. Since the field of operation was the art world, it was natural to frame the images and add passepartout and name the works.

Style is described in terms of personal and social (Meier, 2014). As for the individual style, the personality and the temperament of an artist certainly affect the style of the image. Concerning my own personal style, it shows a persistent tendency to melancholy, a fascination to put things in minor. Perhaps that is why I am also inclined to find a response to the historical imagery that naturally carries with it the nostalgic melancholy of historical experience. After all, it is hard to imagine a personal style separated from the social process of creating representations. Representation is a process in which the way the sign-maker depicts an object is dependent on their psychological, cultural, and sociological background (Kress and van Leeuwen, 2021, 8). On this source of style, the fusion of the personal and cultural, I use the term mental-visual reserve (Raappana-Luiro, 2021, 110). This covers personal and cultural factors: one's personal traits, experiences, memories, and esthetic taste affected by surrounding culture. In the case of this study, the style of my works is inspired by historical images: old still life paintings, and illustrations from natural encyclopedias and field guides. These stylistic similarities work as a connotative semiotic resource with a symbolic power. Concerning the social element of my mental-visual reserve, it is evident that people of a similar age, gender, and cultural background have shared experiences and memories that call forth some shared moods or mental images.

The concept of periodical style or a recognizable personal style of an artist contains the idea of repetition of certain visual features across several representations (Skaggs, 2017, 213). The semiotic power of this kind of style is strongly connected with conventions to use certain

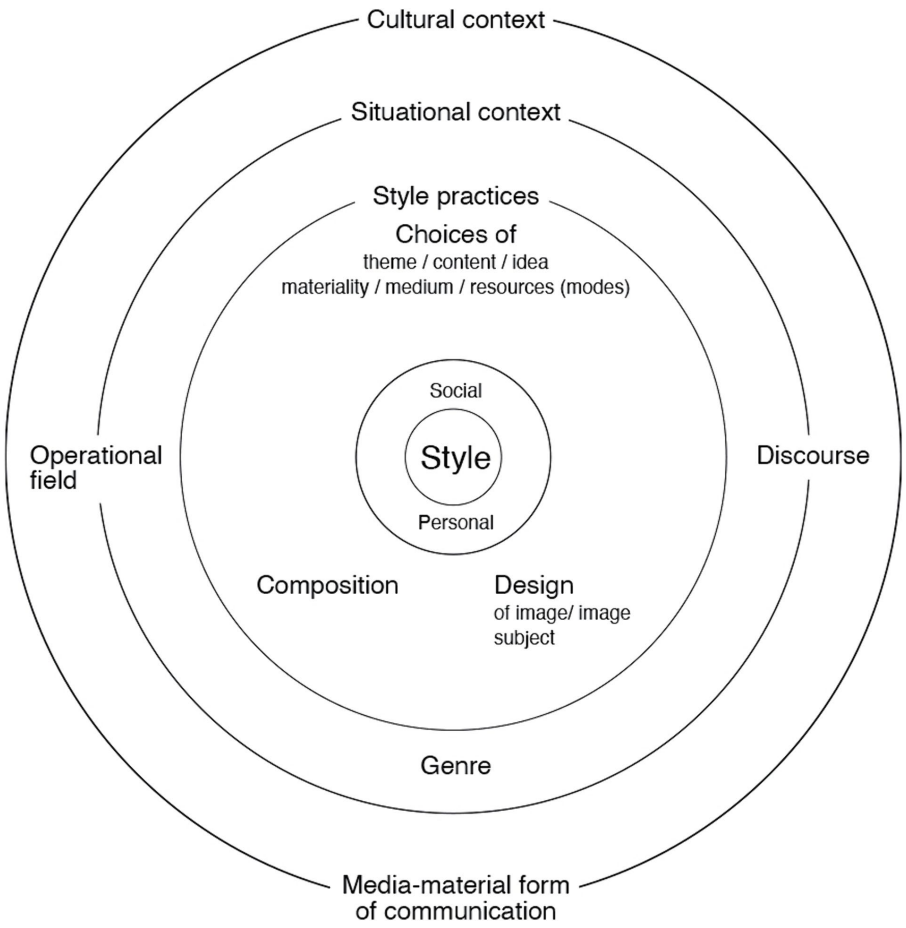

FIGURE 5
Stefan Meier's (2014) model of visual style. Translation and modification by the author.

visual features. Our interpretation of the meanings conveyed by a visual style is based on where we saw a similar style earlier. According to van Leeuwen (2005, 274–276), cultural connotations arise when a sign is transferred from its original environment—time, culture, and social group—to another context. The sign in its new context is also associated with its earlier environment, thus, conveying to the zeitgeist of the past into the present (van Leeuwen, 2005). Periodical styles, isms, are not only a collection of design objects or pictures: they are always manifestations of the values and ideologies of society, of something 'in the air' in a certain historical era and place (see also van Leeuwen, 2005, 69). Via cultural connotations, I transferred the ideas of nature of the Dutch golden age and the Romantic era into today's context, inspired by the visual style of nature imagery of those times. In the case of my works, the stylistic influences are not obvious, but more like intuitive impressions of the imagery from my memory. Nevertheless, the connotations carry with them a stupendous historical legacy of ideas.

In addition to cultural connotations, based on meaning aroused by the similarity to earlier presentations, there is another way, in which semiotic resources make meanings: experiential metaphors. They make use of more universal human experience (van Leeuwen, 2005; van Leeuwen, 2020): for example, we tend to interpret some colors as warm and some visual forms as heavy. In artistic practice, cultural connotations and experiential metaphors work together. In the case of my own works, the pictures make meaning through their cultural connotations with earlier visual styles used in representations of nature. Simultaneously, semiotic resources work metaphorically: for example, we interpret the black background of pictures as darkness, and because of being a diurnal species—and because colors have special potential for affective meanings—we view that blackness as mysterious and unknown (see Pastoureau, 2008; Raappana-Luiro, 2021, 127–128; Raappana-Luiro, 2022). At the same time, we may associate black with the cultural elements of death and mourning (Raappana-Luiro, 2021). Thus, many cultural conventions of meaning making are originally based on experiential metaphors. The little dead body of the bird in my picture would arouse quite different effect on a light (sky)blue background than on the black background.

In Meier's (2014) model, the operational field of an image is connected to discourse. They, in turn, affect the choice of the genre of the images: we tend to associate certain types of content and stylistic features with a certain genre of the image. In the same way that I vacillated between the identities of an illustrator and artist, I also vacillated between genres: as works of art, my images approach popular illustrations. Admiration for the past natural history illustrations also brought connotations to the stylistic conventions of the genre. In this way, also the genre expectations can be mixed,

connoting both with natural history (the style of images) and fine art (as the operational field).

4 Discussions with nature—mental-visual reserve

When you use your own works as research material, it is impossible not to reveal your own experiences and history. For this reason, I am starting with a story from my childhood: I am four or five years old, drifting in the forest and along the banks of the river near my family's wilderness cottage, picking up the most colorful little river-ground stones and putting them in my pocket. I am an explorer on unknown ground, the first to see an emerald-glamoured damselfly over the stream. I also know that at some points in the forest, chickweed wintergreens get a delicate pink tinge in their leaves and flowers. Every little plant, insect and cone is a new miracle for me. I do not care about the mosquitos around me or the clothes that get wet when I immerse myself in a conversation with nature.

This memory is from early 1970s in Finnish Lapland. At home, in our tiny city apartment, there were some books inherited from my grandfather: old nature encyclopedias from the beginning of the 1900s and some field guides on birds and insects. There are still my pencil marks in the bird guide as I have tried to reproduce the pictures with the help of carbon paper. In the encyclopedia, there were reproductions of illustrations from earlier decades made by famous illustrators, including Ernst Haeckel's magical works of bats and sea creatures. Magical were also the texts of these books: descriptions of gigantic whales and small deep-sea creatures shining like lamps offered an enchanting blend of scientific and esthetic pleasure. My affective, experiential relationship with nature was combined with the surrounding cultural discourse found in old natural history books, and I became a kind of esthetic hunter-gatherer, interested in both the esthetic and biological qualities of nature. As got a bit older I even made a small insect collection and set beautiful small stones, cones, and other pieces of nature on my shelf, intuitively making a kind of cabinet of curiosities. I learned to identify different animal and plant species, and when raising caterpillars, I began to understand that butterfly species needed a particular food plants. That way I learned experientially to understand the fragility of biodiversity. My relationship with nature has offered me both a scientific, esthetic, and emotional-affective experience, and has led to the creation of the works that serve as material for this article.

Although the artist in me led me to study literature and art history and finally to training as a graphic designer and illustrator, my relationship with nature has remained close. I am a volunteer species surveyor and still looking for the topics of my creative work in nature. As this study shows, my childhood experiences in nature, as well as the old nature imagery I encountered in my grandfather's books, had a strong impact on my personal style of depicting nature. Later in my life, when studying art history, the style of still life paintings from the Dutch Golden Age also touched me deeply: I was aware of their role as vanitases even before it was told to me. What is essential, however, is that the process of drawing stylistic inspiration from the mental-visual reserve is anything but straightforward, but much more multilayered and filtered by personal traits, memories, and nostalgia. After all, the childhood experience of nature as a miracle has become a regular theme in my depictions of nature.

5 Stylistic influences in a new context: *The end of the world*-exhibition

Scanography as a technique has special semiotic potential. When I started—quite accidentally—to make tests with a flatbed scanner some years ago, the first thing I scanned was the wing feather of a whooper swan. In the past few years, I have been using a mixed technique of scanography, collage, and digital painting to make the fictive illustrations of scanned natural objects (Raappana-Luiro, 2021; Raappana-Luiro, 2022). What was astonishing in this technique, was the somehow unnatural precision of details also in the darkest parts of the picture (see also Buchmann, 2011). This is visually remarkably similar to the historical illustrations, where the technique of skilful hand painting offered the extreme 'bokeh' for objects. The dramatic lightning, where the light source is below the object, created an even illumination which was different from photographic images (Buchmann, 2011). Pretty soon I realized that by using a black background I could intensify the dramatic effect: the colors and the lightning looked more intensive, as if the objects were highlighted from the darkness surrounding them.

It is not surprising, that scanography as a technique is often used somewhere between art and science. In fact, many artists are using scanography especially in presenting objects of nature. An illustrative example of this "work in the middle ground" is the artist Joseph Sheer, who is described by Biologist Buchmann (2011) in an article in the journal *Nature*. The artist Sheer collected microlepidoptera for his scanography works because of their esthetic characteristics. At the same time, he developed his entomologist skills and even observed new species (Simpson and Barnes, 2008; Buchmann, 2011). The technique makes possible the accurate depiction of natural objects and at the same time offers a "more than real" look for the objects (see also Kress and van Leeuwen, 2021, 156–159). This kind of accuracy in terms of the details and shadows creates a sense of dreamlike stagnation (see also Nodelman, 1990, 117–118). In my three pictures, this stillness is heightened by placing the objects—an elk's jawbone, a bird and a cone—in the center of square picture areas thus inducing the viewer to stop and contemplate. By following the convention of natural history illustration, where the objects are depicted on a plain background, separated from their natural surroundings, I came to a visual solution that created a miraculous aura for the natural objects. Like in their historical predecessors, they are not just objects, but objects of contemplation.

The atmosphere of the pictures which inspired me is then a result of the artist's attitude to nature as a wonder, where all the specimens, large and small, are treasures worthy of admiration. The visual style of images which—despite of their seeming realism—express an atmosphere of some profound, magical meaning below the surface of their everydayness has a lot in common with the literary style in narrative fiction called magical realism (Bowers, 2004, 1–29; Vanhaelen, 2012, 1,009; Raappana-Luiro, 2021, 113). When considering the Dutch paintings of seventeenth-century, Angela Vanhaelen (2012, 1009) notes, that it "…suspends a shimmering moment in time, holding up the materiality of life itself for the viewer's attentive contemplation."

Working with scanography is a combination of digital and very material practices. In my case, it needs a lot of time roving in nature and exploring interesting things for material. After the scanning of the elements, there is a digital process of image making. My aim in digital

manipulation was to further dispel the associations with photography and raise the effect of a hand painted picture. My works are usually made for print, which means that I need to think about the semiotic resources of the materiality of printing, too. In the case of *The End of the World* exhibition, I chose to use ink-jet printing. This technology offered a sense of deepness—the effect of objects emerging from the surrounding dark space—which was intensified further by the matte art paper I used. In this way, an atmosphere of dreamlike stillness and a temptation for an attentive and contemplative way of looking were emphasized by the chosen materials. To get even more space around the works I used passepartouts—one of the conventions of fine art. I chose to use slightly creamy white passepartouts, aiming to create an effect of yellowed patina—like in old natural history prints—to my works. All these material solutions descended from my sources of inspiration: a "more than real" atmosphere and the nostalgia of the historical experience.

The meanings I—mostly intuitively, partly intentionally—wanted to express in my three works in *The End of the World* -exhibition, were not of science but of esthetics and emotion. During my life, I have personally experienced the way the human society has changed the nature in my surroundings. There are fewer and fewer forests left around our 'wilderness' cottage. It is not so easy to catch a trout for a meal from the river and not so common to see the beautiful damselflies fluttering over the creek. Nature as a source of wonder as it was in my childhood memories is gradually disappearing. There is no doubt that the feeling of nostalgia and melancholy has contributed my choices of stylistic resources. In illustrating the phenomenon of modern nostalgia, Antto Vihma (2021) notes, too, that the pace of change in modern society is so fast, that today's world seems to be foreign land for many of us. Stylistic connotations to past representations suit the 'emigrant's nostalgia' in which we find a solace in our fragmentary memories (Boym, 2007; Vihma, 2021).

When turning toward history and memories, an artist always carries a melancholic undertone. Historical representations as such are experienced as a reminder of the "unattainability of all the world and of the past" (Ankersmit, 2005, 178; Raappana-Luiro, 2022). By using historical images as a form of stylistic inspiration, I inevitably conveyed a sense of melancholy in my artistic works. This melancholy of historical experience is made even more intensive by the stylistic references to vanitases of the Dutch Golden Age with their dark backgrounds and dramatic lightning.

Before the invention of photography, the illustrators of natural history, striving for realistic depictions of specimens for classification, used collected, dead animals as their models. When writing this essay, I found an image of a painting made by the well-known Finnish nature artist Wilhelm von Wright (Figure 6). The still life, made in the first half of 19th century, depicts a small bird, a linnet. It was probably killed by the painter, and hung on the wall, tied by its leg. Von Wright's painting has an amazing likeness to my picture titled *Exitus (Spinus spinus)* (Figure 2). However, the story behind *Exitus* is different. I found the bird, a siskin, in my backyard. It had flown into the window and died. I constructed a net of beard moss and placed the tiny, still warm, dead body onto the scanner glass. The moment was almost spiritual, and for me, the death of the bird grew to represent universal suffering and mourning.

As for the other two works, *Ark* and *Seed* (Figures 1, 3), their meanings are more ambivalent. As a triptych, the meanings of all three pictures are formed by their mutual relation. My 'cabinet of curiosities' comprises quite common species: an ordinary little bird, an elk's jawbone and a cone of a Swiss pine from the city park. The elk's jawbone in *Ark* I was picked up from a little sandbar in the middle of a river in the Oulanka national park in North Eastern Lapland. I made an experiment and put a small piece of moss on the bone before scanning. There were some bilberry twigs growing through the moss, and after the scanning process, I realized the contrast between dead and living nature. In my imagination, the jawbone became a surrealistic ship, carrying life within. In a similar way, the ordinary cone in *Seed* took on a miraculous value as a source of new life. Finally, to limit the sphere of interpretation, I named the pictures *Exitus* (*Spinus spinus*), *Ark* and *Seed*. The word 'exitus' is commonly used of the moment of human death. In the context of an animal, the name gives rise to anthropomorphism, representing the death of the bird and human as equal. By adding the scientific name of the bird to the title of the picture I intentionally mixed the contexts: the genres of specimen illustration and a work of fine art. The use of scientific names works as a metonymy of the whole species, expanding to represent all the living creatures that are at risk of extinction. As a whole, the series of images could be represented as neutralized taxonomic illustrations, but intertwined with a semiotic resource of language—the titles of the works—their meanings are focused on mourning for the loss of nature. My aim in this mixing of genre expectations was to hint for the scientific relation to nature.

By connoting the works to the cultural history of representations of nature as a miracle—past cabinets of curiosities, natural history illustrations and still lifes—my works convey an atmosphere of nostalgia and melancholy. In the new context the stylistic choices, without question, are related to my personal nostalgic memories, but possibly also to some shared nostalgia in a world that changes too fast

FIGURE 6
Wilhelm von Wright. *Hemppo*. 1830–1839. Gouache on paper. Finnish National Gallery (©https://www.kansallisgalleria.fi/fi/object/480986).

around us. In a world, where all the everyday miracles of nature are going to be rarer, day by day.

6 Conclusion

In this essay, I have reflected on the stylistic choices in the practice of semiotic meaning making. In my works, the cultural connotations to past representations of nature are made use of to create an atmosphere of seeing nature as a wonder, combined with the nostalgia and melancholy of historical experience. The melancholic atmosphere is developed further by connoting the work to the stylistic conventions of vanitases. Even though the works I have focused on are exhibited in the context of the art world, my personal interests are in popular imagery. This interest is echoed also in the representations that have inspired me: cabinets of curiosities, still lifes, and past natural history illustrations all have a kind of popular origin in the field of art and natural sciences. Still life pictures were hung on the walls of bourgeois homes, while cabinets of curiosities were collected by passionate enthusiasts and later used as part of exhibitions in popular museums. The work of early natural history taxonomists was continued among enthusiasts willing to observe the different specimens of animals and plants.

All of the aforementioned genres of representation of nature use the convention of realistic depiction, which has its roots in Renaissance's ideal of the immediate observation of nature. However, the styles of representation were developed in close interaction with other images. As Brian Ogilvie (2006, 141) notes, "[t]he sixteenth-century naturalist was constantly in motion— motion between the library, the cabinet, the salon (or dinner table and printers' shop), the garden, the wharf, and the countryside—." According to Kress and van Leeuwen (2021,154) we still judge the realism of images on the basis of the old technology of 35 mm photography. In my works, there are some elements which are 'more than real': especially the extreme precision and detail and the manipulation of the size of the objects. One element that make the images look 'less than real' is the elimination of the background, an early formed convention in natural history illustration.

In the works in *The End of the World* -exhibition, the elimination of the background was used to emphasize attentive viewing. Via the effect of stillness, which is characteristic to the precision of depiction, the images create a way of looking that is simultaneously attentive and contemplative (Vanhaelen, 2012). It seems, that a similar way of looking is typical for nature enthusiasts, too. Thomas Fleischner argues that the field experience of a naturalist is based on a special state of mind and a special kind of looking, where "a seamless merging of attentiveness outward and inward, toward the interwoven realms of nature and psyche" takes place (Fleischner 2011, 7). As for the concept of biophilia (Wilson, 1984), it deals with our innate tendency to focus on the living nature surrounding us. The attitude of an explorer, searching for novelty and diversity in nature, is typical for biophilia. According to Edward O. Wilson (1984, 1), biophilia is also the key to understanding the value of nature and protecting it. Fleiscner's and Wilson's writings put into words my own experiences underlying the works analyzed in this study.

Today – as opposed to my historical sources of inspiration – the discourses of natural science seem to differentiate from discourses of art. My personal relationship with nature has been biophilic and, by implication, colored by empathy toward all living creatures. This empathy is more by concretely living with nature than from pictures of it, so I am a bit skeptical about the power of images as such to create biophilia. According to Whitley et al. (2021), the anthropomorphism of nonhuman animals in portraits of endangered species evoked greater empathy among the survey participants than a traditional wildlife photographs of a species. As for my own works, I hung *Exitus (Spinus spinus)* in the middle of the series of the three because of my emotional identification with the bird. Compared to it, the two other works seem more conceptual. Undoubtedly, in the purpose of popularizing the nature discourse, these kinds of animal portraitures are more effective at creating empathy and a conservative attitude toward nature than, say, visualized statistics of the extinction of species.

From the perspective of post-colonialist and posthumanist thinking, my sources of inspiration could be seen as questionable. Past depictions of nature date back to the time of the expeditions to new colonies and taxidermies of exotic specimens. Nevertheless, without the history of classifying, describing, and collecting we were unaware of biodiversity—with whom we live on this planet and who we have to protect from extinction (Flannery, 2023, 7). I hope that the cultural connotations I have created by using historical images as a stylistic resource are those of wondering, contemplating, and experiencing the miracle of nature.

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Blurring bioart boundaries

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This study investigates the intersection of bioart and posthumanistic perspectives through the innovative use of reindeer by-products, specifically reindeer blood, as a medium for artistic expression. Utilising an Arts-Based Research (ABR) approach, the research investigates the methodological, ethical, and cultural dimensions of integrating waste materials into creative practices. The project repurposes reindeer blood, an often-overlooked by-product of reindeer herding, to provoke ethical discussions on sustainability and cultural sensitivity within the arts. Experiments in the BioARTech laboratory transform reindeer blood into air-dried pigment, which is then incorporated into glassblowing and surface pattern design. These innovative techniques challenge traditional boundaries of artistic materials and prompt deeper reflections on human-nature relationships. Exhibitions across Finland highlight the ethical application of this unique Northern material, highlighting its cultural significance and promoting a reimagining of our interconnectedness with the natural world. Ultimately the study expands the artistic repertoire and advocates for more harmonious and sustainable futures through pioneering bioart practices.

KEYWORDS

bioart, posthumanism, arts-based research, human-nonhuman relationship, animal by-products, artistic experimentation, sustainable art practices, ethics

1 Introduction and background

Imagine a painting brought to life with the vibrant rhythms of natural materials instead of just chemically enhanced paint and pigments, or a glass piece incorporating unusual natural waste materials as artistic elements, blending the lines between art and nature. This study seeks to explore this unfamiliar territory, where traditional boundaries collapse and new research paths emerge. The authors (artist-researchers) of this study are guided by the principles of posthumanism which offers deep insights into the fluid nature of identity, agency, and morality (Haraway, 1991). The language of the life sciences provides artists with a valuable communication tool for exploring evolving concepts of identity (Myers, 2015). In this vast expanse of artistic expression, bioart emerges as a beacon, encouraging us to reconsider our assumptions and reinvent the fundamental core of creativity (Kac, 2007).

Borrowing from Stracey (2009), this study focuses on the posthumanistic approach within bioart as a platform for critically reflecting on the ethical implications of manipulating natural materials for artistic purposes. As bioartists investigate genetic engineering, biotechnology, and synthetic biology, issues such as agency, consent, and environmental impact become crucial (Vaage, 2016). Posthumanistic discourse encourages bioartists to question the power dynamics inherent in their creative processes and the ethical implications of their interventions in biological systems. By acknowledging the agency and vitality of non-human entities, posthumanist scholars challenge anthropocentric attitudes toward the environment and advocate for more symbiotic modes of coexistence (Barad, 2007). Through this lens, bioart becomes not only a platform for aesthetic experimentation but also a site for ethical inquiry and dialogue, challenging

viewers to confront their assumptions about the boundaries of life and the responsibilities of human creators, as Herbrechter (2023) asserts.

Bioart intervenes in life processes, pushing its boundaries through the creation or alteration of natural materials, suggests Kac (2007). Unlike traditional art forms, bioart surpasses representation, residing inside the world of the living. The resulting bioart creations become integrated into the ongoing process of evolution and, if capable of reproduction, may endure as long as life exists on Earth. Consequently, bioart prompts novel inquiries into the future trajectories of life, evolution, society, and artistic expression. According to Beaudoin (2021), 'bioartistic practices have the potential to contribute to a broader reconfiguration of human beings and their relationships with the environment, providing productive avenues for addressing the environmental crisis' (p. 165). By decentering the human subject and embracing a more-than-human perspective, bioartists can envision worlds where humans and non-human entities collaborate, co-create, and co-evolve (Kac, 2007). Through speculative narratives within bioart, audiences are encouraged to consider the possibilities offered by advancements in our artistic imagination, as well as the implications these innovations may have on shaping our shared futures.

The authors of this study began their exploration with a posthuman design project called *Life Between Art and Blood*, (Pietarinen and Qureshi, 2023a,b,c). Using an arts-based research (ABR) approach, they sought to integrate posthuman design and kinship between humans and non-humans within the BioARTech laboratory, which experiments with Northern waste materials (BioARTech Laboratory | Faculty of Art and Design | University of Lapland, n.d.). This qualitative research aims to repurpose reindeer blood, a by-product of reindeer herding, rather than treating it as waste, and to generate new ideas related to this material (Kontturi, 2012; Pietarinen and Qureshi, 2023a,b,c; Qureshi et al., 2023). Rooted in ABR, which highlights experiential knowledge generation and the integration of artistic practice with scholarly inquiry (Barone and Eisner, 2012), this study explores the multifaceted implications of reindeer blood as a medium for artistic expression, while also investigating the societal, environmental, and cultural implications of this approach.

1.1 Ethical considerations

Although the research involved the use of animal by-products (ABP), ethical considerations were addressed through the European Commission's Ethics self-assessment, ensuring that methods, materials, and results did not cause harm to humans, animals, or the environment (Biorisk Management, 2006; EU Grants, 2021). The use of animal blood in ABR currently lacks significant economic value and often sparks ethical controversy. While animal exploitation is more prominent in industries such as fashion and textile design, philosophical considerations surrounding animals have traditionally centred on rationality and sensitivity, acknowledged as essential issues in animal research ethics since the 1970s (Aaltola, 2004). Keeping this in view, this study also looked into the ethical implications of using reindeer blood in artistic expression, shedding light on the various moral reactions and perspectives it elicits. Ethical inquiries concerning reindeer blood research range from practical considerations to broader ethical principles and solutions encompassing human, non-human, and animal interactions. The study clarifies that no animals were harmed, nor is that the study's aim. Instead, the objective is to repurpose ABP to stimulate deeper conversations about responsibly managing waste materials.

This exploration also intersects with the long-standing tradition of Indigenous peoples using animal blood to create scenes on cave walls, commonly referred to as Rock Art. Unlike Western perspectives that may classify these creations as mere artistic expressions, Indigenous communities view them as integral to ceremonial rituals, reflecting profound cultural significance (Eliade, 1959; Morris and Staikidis, 2023). This distinction raises critical questions about the interpretation of bioart and the ethical implications of using ABP in contemporary practices. The ethical considerations in this research also extend to honouring Indigenous perspectives, inviting a deeper examination of how bioart can respect and incorporate Indigenous knowledge systems (Haraway, 2020) while acknowledging the cultural and spiritual dimensions inherent in these materials.

2 Materials and methods

2.1 Reindeer herding in Finnish Lapland

Reindeer herding stands as a central attraction for visitors to Lapland, celebrated not only for its economic contributions but also for its profound cultural significance. The practice of reindeer herding is deeply rooted in principles of ethics and ecology, underlining its sustainable approach to utilising natural resources (Pietarinen et al., 2023a,b). In Finnish Lapland, the year of a reindeer follows the northern rhythms of nature. In Finland, an estimated 120,000–130,000 reindeer are born every year and about 100,000 reindeer are slaughtered annually in autumn and early wintertime. Almost all the reindeer slaughterhouses in Finland are owned by the *Reindeer Herding Association* (Paliskunta). This is a unique system because in other Nordic countries, reindeer slaughterhouses are owned by companies outside of reindeer husbandry, while the entire Finnish reindeer slaughterhouses are operated by reindeer husbandry entrepreneurs.

Nowadays, about two million kilograms of by-products are produced in reindeer slaughterhouses in Finland. The largest number of by-products are stomachs, digestive systems, loins, heads and blood. Only reindeer meat is maximally used, while the waste is typically delivered to landfills. A wide range of reindeer by-products should be used to preserve resources. For example, reindeer blood has high nutritional and energetic value, and reindeer fur, with its thickness (up to 3–3.5 centimetres, approximately 1,700 hairs/cm^2), acts like a natural insulation layer. Furthermore, reindeer by-products contribute extensively to various sectors beyond traditional consumption. They are employed as raw materials in designed goods, pet food production, and specialised facilities for technical applications, biogas generation, and composting. This multifaceted utilisation not only enhances economic efficiency but also aligns with sustainable practices by minimising waste and maximising resource efficiency (Laaksonen, 2016; Majuri et al., 2019; Muuttoranta, 2019; Mattila, 2021).

2.2 Research environment and artistic experiments

The BioARTech laboratory, located within the University of Lapland's Faculty of Art and Design, served as the primary research

hub where the artist-researchers of this study probed into new frontiers. This dedicated space facilitated safe experimentation and the development of innovative methodologies for working with reindeer by-products, notably blood. Activities in the laboratory were characterised by a commitment to material-driven design and co-creation, where the inherent characteristics of materials themselves played a pivotal role in shaping creative processes. Through a series of carefully designed experiments, the artist-researchers explored the artistic potential of reindeer blood. This approach nurtured a dynamic exchange between theoretical insights and practical applications, pushing the boundaries of artistic exploration. Insights gained from these experiments were showcased in several exhibitions between 2023 and 2024. These included *Blood, Ice and Tears: Life Between Art and Blood* at Gallery Kopio, University of Lapland (Bergström et al., 2023; Pietarinen et al., 2023a), *Materials Matter* as part of Innovation in Lapland through Design and Art, Gallery Hämärä, University of Lapland (Pietarinen et al., 2023b) and *North Meets South* at Gallery Seinä, University of Lapland (Miettinen et al., 2024).

Haraway (2020) underscores the importance of reflecting on the implications of using non-human materials, emphasising the interconnected relationship between humanity and the natural world. This perspective resonates with the cultural beliefs of the Sámi people, as demonstrated by duojár (Sami handicraft expert) Magga (2024), who prioritised respect for nature and acknowledged the interconnectedness of human actions with the environment. This holistic approach underscores the ethical use of natural resources and recognises the intricate web of life, where each entity holds significance. Within Sámi culture, practices such as Duodji, the traditional Sámi handicraft not only involve craftsmanship with natural materials but also reflect a deep respect for reindeer life. These cultural practices serve as a reminder of the shared relationship between humans and nature, advocating for sustainable coexistence and harmony within the ecological framework.

For instance, conversations of the Norwegian artists duo Karoline Sætre and Øyvind Novak Jenssen provided a tangible exploration of similar themes, particularly regarding their innovative use of blood as a central element in their work. Sætre and Jenssen have extensively engaged with various ABPs, including fish intestine, skin, and gallbladder, integrating them into projects that blend dining experiences, place-making, and contemporary art. Their installations and performances often take the form of events where audiences can taste dishes prepared from locally sourced raw materials, exemplified by their *Felles Jord, Delt Bord* (Shared Earth, Shared Table) installation and performance in Harstad, Northern Norway (Sætre and Jenssen, 2023, 2024). In this particular example, participants were invited to dine at a long table crafted from burnt wood, symbolising a communal gathering that embraced the local environment's essence. Thus, reminding us that such immersive experiences not only engage with the senses but also prompt reflections on the interconnectedness between humans and their surroundings.

2.3 Ethical debates and public concerns on the use of reindeer blood

In this research, the concept of the abject and uncanny in bioart, characterised by its ability to evoke intellectual uncertainty and bring to light elements that challenge conventional understanding, was a prominent theme (Jentsch, 1906; Campagna, 2018; Sederholm, 2020; Eco, 2021). Using reindeer blood as an ABP in this project generated discussions at international conferences. It generated significant ethical concerns, leading to debates and astonishment at several events. Notably, these discussions took place at the Textile Intersections conference at Loughborough University London (2023) and the Critical Arctic Studies Symposium at the Arctic Center at the University of Lapland (2023). These platforms highlighted the complex ethical landscape surrounding the use of ABP in art, particularly focusing on the intersection of cultural practices, sustainability, and artistic innovation.

At these conferences, several critical questions emerged from attendees, reflecting a broad spectrum of ethical considerations. One of the most pressing questions was, "How many reindeer have died because of the *Life Between Art and Blood* research?" This question underscored concerns about the direct impact of artistic projects on reindeer populations and the potential for such projects to contribute to animal deaths, raising ethical questions about the justification of using ABP for art. Another frequently asked question was, "From where and how do you get the reindeer blood?" This inquiry highlighted concerns regarding the sourcing of reindeer blood, emphasising the need for transparency in the supply chain. It reflects broader societal concerns about the origins of materials used in creative practices, ensuring that they are sourced responsibly and ethically. Attendees also questioned the broader ethical implications of using reindeer blood in research, asking, "Is it ethical to use reindeer blood for research purposes?" This question invited a deeper discussion on the moral responsibilities of the authors of this study. It challenged them to justify using such materials in non-traditional ways, prompting a re-evaluation of ethical standards in bioart. Practical concerns about handling reindeer blood were also raised with the question, "Do you handle reindeer blood with your bare hands?" This question pointed to personal safety and hygiene, as well as the proper handling and processing of ABP. Lastly, the question, "What do reindeer herders think about this research?" brought greater attention towards the perspectives of Indigenous and local communities who are directly involved in reindeer herding. This question also touched on the potential cultural appropriation and the need to engage with reindeer herders collaboratively and respectfully.

2.4 Research inquiries and insights

Understanding these questions and ethical issues arising from what artist-researchers can do, what is their role in this study, and more specifically how living material is received, was needed (Vaage, 2016). In response to these questions, this article addresses the following research inquiries: (i) What methodological and theoretical considerations emerge when using reindeer blood as a medium for artistic expression, and how do these influence the public perception of such practices?, (ii) How can ABR methodologies be adapted to incorporate reindeer blood and other non-human materials in a sustainable and ethically responsible manner? and (iii) In what ways can incorporating reindeer blood into artistic activities encourage cultural dialogue and understanding between human and non-human communities, impacting the broader cultural, environmental and societal landscape regarding the use of unconventional materials?

These questions underscore the necessity for discourse, collaboration, and shared understanding in material studies.

The first research inquiry investigates the methodological and theoretical considerations that arose when using reindeer blood as a medium for artistic expression. Methodologically, it was understood that we must navigate the ethical sourcing and handling of the blood, ensuring that its use aligns with both legal and ethical standards. The selection of reindeer blood, classified as an ABP is deliberate due to its unique properties and cultural significance within the context of Finnish Lapland. ABP refer to materials of animal origin that people do not consume. In this experiment, 14 litres of low-risk (Category 3) frozen reindeer blood was delivered directly to one of the author's doorsteps. Reindeer blood can also be purchased in regular grocery stores in Finland. Handling, storage, and transportation of such by-products are regulated by stringent health guidelines outlined by the European Parliament (Regulation No. 1774/2002), ensuring compliance with ethical standards and environmental safety protocols. For instance, low-risk material category 3 means that the blood originates from healthy animals or has been obtained from reindeer declared fit for human consumption after undergoing an antemortem inspection (Animal by-Product, 2008; Regulation (EC), 2009; Commission Regulation (EU) No 142/2011, 2011; Mattila, 2021).

The second research inquiry focuses on how ABR methodologies can be adapted to incorporate reindeer blood and other non-human materials in a sustainable and ethically responsible manner. Adapting ABR methodologies involves several key strategies. Ethical sourcing is paramount, ensuring that materials are obtained from responsible and sustainable practices. Regulatory compliance with health and safety standards protects both artists and the environment. Collaborative practices with local communities, including Indigenous groups such as the Sámi, ensure cultural sensitivity and respect. Educational initiatives can raise awareness about the ethical and environmental implications of using non-human materials, promoting informed dialogue and understanding. Sustainable design practices can minimise waste and maximise the use of all parts of the reindeer by-products, enhancing the overall sustainability of the practice.

The third research inquiry examines how incorporating reindeer blood into artistic activities can encourage cultural dialogue and understanding between human and non-human communities, impacting the broader cultural, environmental, and societal landscape regarding the use of unconventional materials. Incorporating reindeer blood into artistic projects highlights the cultural significance of reindeer herding for Indigenous communities, raises awareness about sustainability and ethical considerations, and advances interdisciplinary collaboration. Artistic experiments using reindeer blood can captivate public interest, sparking curiosity and deeper conversations about the interconnectedness of human and non-human life, the value of biodiversity, and the need for harmonious coexistence. Through these efforts, artists can create a ripple effect, influencing broader societal attitudes towards the use of unconventional materials and promoting a more integrated and holistic view of our relationship with the natural world.

2.5 Porohelmi (reindeer pearl)

Considering the inquiries and insights mentioned earlier, this experiment investigated the transformative potential of organic material, focusing initially on reindeer blood, which, despite its unsettling connotations, was transformed into an air-dried red pigment for artistic exploration. The direct interaction with the blood using bare hands elicited both caring and unsettling experiences for the artist-researchers. This interaction raised a sense of connection and responsibility towards the material, leading to a deeper appreciation and "care" for it. This can be illustrated through the properties of blood, such as the colour changes from fresh red to rust brown, it effectively stains fabric, and the stains fade upon washing. Similarly, a textile printed or woven with blood can be interpreted from multiple perspectives, symbolising themes of life, passion, and mortality. This challenged traditional notions about the relationship between humans and non-human within the framework of posthuman design.

The creative process began as the artist-researchers collaborated with a multidisciplinary glassblowing expert team at Ikaalinen College of Crafts and Design to experiment with air-dried reindeer blood pigment in glassblowing and surface pattern design (see Figure 1). This partnership offered a fertile ground to explore how the blood pigment adhered to and was applied on various surfaces, ranging from traditional materials like wood and paper to unconventional mediums such as gluten plastic, beeswax, and bio-based thermoplastic. This exploration aimed to reveal how the pigment could be used to create intricate patterns and textures, enhancing the visual and tactile experience of the artwork. Moreover, the team experimented with different temperatures and techniques to understand how the pigment interacted with molten glass. This stage was characterised by iterative trials, where the pigment's behaviour under various conditions was meticulously documented. This required precise control of temperature and timing to ensure that the pigment was effectively fused into the glass without compromising the clarity and integrity of the material. The resulting glass objects, including spheres and patterned surfaces, captured the unique visual qualities of the blood pigment.

This entire process took place during a week-long workshop, where the artists collaborated intensively working with the expert glassblowing team for 5 h each day (Pietarinen et al., 2024). Through detailed documentation and reflection, the artist-researchers aimed to capture the unique aspects of their creative process, including the tools used, outcomes achieved, and insights gained for future artistic applications of blood materials. One researcher participated remotely, observing the workshop online intermittently to provide a viewer's perspective. This dual approach allowed the authors to analyse the data comprehensively from both physical and virtual viewpoints, ensuring thorough documentation and perspective integration among all collaborators.

The final artwork *Porohelmi* emerged from this experimental process as a series of glass spheres infused with reindeer blood pigment. The name, meaning "reindeer pearl" in Finnish, reflects the translucent, lustrous quality of the glass, reminiscent of water pearls. The spheres were designed to embody a sense of organic beauty and fragility, symbolising the interconnectedness of life and the momentary nature of existence. The process of integrating reindeer blood pigment into glassblowing involved several stages, each contributing to the development of this artistic work. The glass spheres were not merely decorative but served as a medium to explore and express broader themes. The use of blood pigment highlighted

the material's inherent duality—its association with both life-giving and life-ending forces. The transformation of blood from a biological substance to an artistic pigment underscored a journey from raw nature to refined art, encapsulating a narrative of change and continuity.

Subsequently, the artwork was showcased at the *Growing Season* Exhibition at Taito Gallery, Craft Corner in Helsinki (Pietarinen and Qureshi, 2024) as part of the Bio Colours Conference organised by the University of Helsinki (see Figures 2, 3). During the exhibition, the artwork gathered significant interest and prompted inquiries from the

FIGURE 1
Glassblowing workshop at Ikaalinen College of Crafts and Design, Finland (2024). Experimenting with air-dried reindeer blood pigment for surface pattern design (left); Blowing glass with expert Eija Yli-Knuutila and author Heidi Peitarinen (right). Photo credits: Merja Virta.

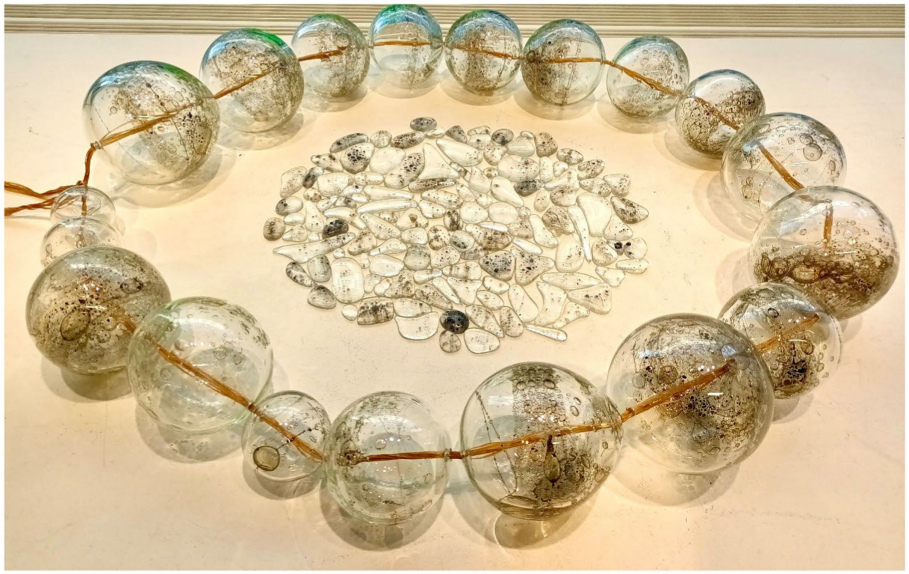

FIGURE 2
Porohelmi (Reindeer Pearl), Exhibited at Taito Gallery, Craft Corner in Helsinki, Finland (2024); Materials: Glass, air-dried reindeer blood and vein thread; Technique: Glass blowing; Experts: Eija Yli-Knuutila and Merja Virta; Photo credits: Heidi Pietarinen.

FIGURE 3
Closeup of air-dried reindeer blood blown into glass. Porohelmi (Reindeer Pearl), Exhibited at Taito Gallery, Craft Corner in Helsinki, Finland (2024). Materials: Glass, air-dried reindeer blood and vein thread; Technique: Glass blowing; Experts: Eija Yli-Knuutila and Merja Virta; Photo credits: Heidi Pietarinen.

audience. Unlike previous instances, this time the artist-researchers were equipped to address questions arising from the uncharted territory they had initially ventured into. Feedback from the audience and critics emphasised the provoking nature of the work and its capacity to stimulate thought on cultural, environmental, and societal themes. The artwork's ability to bridge traditional craft with contemporary issues reflected a successful fusion of artistic innovation and conceptual depth. This ongoing process of knowledge dissemination, dialogue and exploration continues to uncover new possibilities and insights. Moreover, this experiment not only expanded the artistic repertoire of the team but also ignited critical discussions about the cultural, environmental, and societal implications of employing unconventional materials in artistic activities.

3 Results and discussion

Reindeer blood, as a by-product, exhibits fascinating and unique properties that defy easy categorisation. Audiences at the exhibitions found it challenging to believe that the surface pattern design on glass was created using air-dried reindeer blood pigment. One attendee exclaimed in disbelief, "Is it really reindeer blood?" Another inquired, "How does the colour change to black, and yet it appears as if snow is trapped in the glass?" Observers also noted that the round and smooth glass surfaces allowed them to clearly discern the intricate patterns, reminiscent of a snowstorm. For the artist-researchers themselves, the patterns on the glass surface differed significantly from those achieved with other substances like "soda" (sodium oxide,

Na_2O) or snow used for processing modifications. The process and outcomes of working with reindeer blood pigment prompted deep reflection and exploration, challenging conventional perceptions of materials in artistic practices.

The unifying theme across all previous exhibitions and the latest *Porohelmi* exhibition was a deep respect for Northern nature and its by-products, with a focus on finding innovative ways to incorporate diverse elements into art and design. The dissemination of *Porohelmi* represents a significant achievement in blending traditional techniques with innovative material use. The artwork served as a shred of evidence of the potential of reimagining materials and pushing the boundaries of artistic practice, inviting viewers to engage with complex themes of life, transformation, and materiality. This approach demonstrated that blurring the boundaries of bioart requires more than just artistic expression—it demands dialogue, networks, collegial encounters, and shared authorship, fostering a sense of kinship between humans and non-humans. The use of reindeer blood raised immediate questions about mutual respect for nature, highlighting that humans cannot thrive without a harmonious relationship with the natural environment. It reminds artist-researchers to consider the multiple and interconnected entities that every new material inevitably influences and shapes (Haraway, 2020).

Additionally, the research relies on observations and lacks a clearly defined sample size or systematic methodology for selecting public responses. Scoping studies emphasise breadth over depth, aiming to map the existing knowledge landscape and identify key themes, gaps, and areas for further exploration rather than producing definitive statistical conclusions (Munn et al., 2018). In this study, findings arose from spontaneous public reactions and feedback observed during conference presentations and exhibitions, providing valuable insights into audience perceptions and responses. Such qualitative data act as an initial exploration of themes and variables that merit further investigation, aligning with the aims of scoping studies, which prioritise understanding the scope of an issue over establishing concrete cause-and-effect relationships (Peters et al., 2015). While the lack of a structured sampling method and calculative approach may limit the findings, on the other hand, it reflects the exploratory nature of this research. By showcasing diverse perspectives, this study contributes to future inquiries into the intersection of art, ethics, and public engagement, paving the way for more systematic investigations (Arksey and O'Malley, 2005).

4 Conclusion

In conclusion, the exploration of reindeer blood has illuminated thoughtful themes of interconnectedness, empathy development towards a more balanced ecosystem, and a critical examination of human supremacy over other species. Through the lens of posthumanism, this research has sought to decenter the traditional view of humans as autonomous and fully separate from nature. Instead, it proposes a vision where humans are understood as part of a broader assemblage, co-evolving with other life forms and deeply embedded within the environment, materiality, and technology (Nayar, 2013, p. 13 and Keski-Korsu, 2019, p. 237). Looking ahead, the insights gained from this research underscore the importance of continuing to explore and integrate non-human entities into creative processes. As we navigate the complexities of a rapidly changing world, embracing a posthuman perspective invites us to reconsider our roles and responsibilities towards all forms of life, encouraging a more harmonious coexistence with the natural world. In essence, the exploration of reindeer blood has demonstrated the transformative potential of unconventional materials, challenging us to reimagine our relationship with nature and each other in ways that are both innovative and harmonious.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

HP: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. AQ: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The creative cosmos beyond humans: a symphony of participatory design and visual artificial intelligence

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As artificial intelligence (AI) continues to pervade our daily lives, expanding the boundaries of participatory design to include aspects of visual communication beyond humans is imperative. This research explores the intriguing convergence of participatory design and AI-enabled visual-based design as powerful methodologies for shaping the creation of new ideas (e.g., products/services). The specific research objectives are 3-fold: to unravel the nuanced dynamics in terms of perception inherent in the increasingly intertwined visual communication between humans and AI (e.g., sketch AI); to investigate how AI-enabled visual communication supports the participatory process with stakeholders; and to explore their experiences in AI-enabled visual-based design for non-human subjects (e.g., animals and plants). A laboratory study of 18 experimental groups found that AI-enabled visual-based design significantly enhances creative ideation performance when (novice) designers engage AI as a partner rather than merely a tool or collaboratively interact with stakeholders. Notably, the engagement level of internal stakeholders is much higher than that of external stakeholders.

KEYWORDS

participatory design, visual AI, sketching, non-humans, stakeholder communication

Introduction

Since the Bauhaus laid the foundation for modern design, every modern design is "if not explicitly participatory, at least programmatically collaborative" (Bannon and Ehn, 2012). Participatory design makes participation and skill development explicit and crucial in creative design practices (Schuler and Namioka, 1993). Extant participatory design practices have embraced diverse technologies, tools, environments, and businesses (Simonsen and Robertson, 2013). One central issue has been how human agents can drive the collaborative design process. With the increasing adoption or incorporation of artificial intelligence (AI) technology and applications by human agents, various new forms of intervention in the collaborative design space are apparent. Key benefits of involving AI include enhanced efficiency, improved prediction (e.g., of individuals' behaviors), and reduced time and human error, offering significant value to stakeholders' communications (e.g., Eisingerich et al., 2021). Recent examples of large language models (LLM) like Open AI's ChatGPT-4 can facilitate both verbal and text-based interactions, enabling dynamic communication in the design practice. Some particular AI agents, like AutoDraw, can assist with visual-based design by providing quick and intuitive sketching capabilities to suggest creative designs, thus coined "sketch AI" in this study.

Sketching as a central design skill has drawn strong academic interest in creating novel ideas within groups in modern design (Van der Lugt, 2005; Paay et al., 2023). Often as a visual form, sketching has been proven to support human agents in problem identification, idea exploration, and solution development in an effective and depictive way, thereby helping communicate their ideas to other stakeholders in design meetings by using papers or digital media to date (Fish and Scrivener, 1990; Van der Lugt, 2005; Olofsson and Sjölen, 2006; Paay et al., 2023). However, there has been a lack of research on the participatory process of stakeholders engaging with a visual-based (sketch) AI agent in creative design.

Nevertheless, the increasing demands for integrating technology and social, economic, and environmental values further press the need to include both humans and non-humans in creative design practices. This expanded focus on design underlies more inclusivity for creating more adaptable solutions. By incorporating the perspectives and impacts of non-humans, such as animals, plants, and even AI agents, whereby verbal communications can be restricted, the inclusivity in a visual-based design fosters a deeper understanding of diverse contexts in which complex interactions between people, technology, and the world occur.

Instead of a single theory or technique, participatory design not only represents a collection of diverse perspectives and experiences but also a predominant value (Schuler and Namioka, 1993). It prioritizes a more humane and effective relationship between stakeholders involved in the design process to meet end-users' needs and preferences (Schuler and Namioka, 1993). The participatory design-related design traditions have been within the realm of human-centered approaches, emphasizing the direct involvement of human representatives as the stakeholders in creative practices (Wilkinson and De Angeli, 2014). The conceptualization of the process reflects the possible collaborative efforts that could foster a sense of ownership and empowerment among the involved stakeholders as a group and ultimately lead to more innovative and user-friendly designs. One classic model to study the participatory design group emphasizes the placement of the group through the entire design process (Wilkinson and De Angeli, 2014). In this research, we adapted this model to conceptualize the involvement of an AI agent for creative ideation beyond just humans (see Figure 1).

The adapted model maintains the group's original central role while distinctively incorporating an AI agent into the group, highlighting its possible contributions to the participatory design process in front-end design. The other adaptation informs the front-end design process in the model, particularly regarding creative ideation. The cycle of the four main designerly activities concerning creative ideation is specified from problem to solution. It is worth mentioning that the activity starts with problem identification, which is not limited to human needs but also extends to non-human related needs or subjects. Then, a series of activities related to creative ideation follows within the solution space. In light of Sanders (2002) notion of participatory design, each agent from the participatory group is believed to offer inputs at every stage of the design process when having the media to express themselves in terms of generating new thinking and ideas. Sketching is acknowledged as an appropriate medium to capture

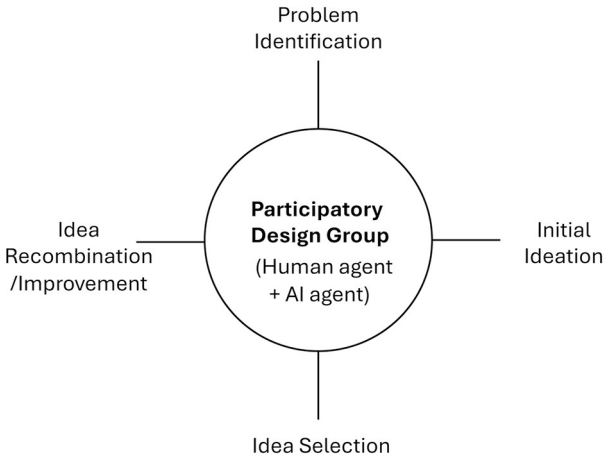

FIGURE 1
Model of researching participatory design groups for creative ideation in the AI age.

current thoughts, inputs, and feedback from everyone involved (e.g., designers and stakeholders), ideally at every stage, with input from everyone involved. This study, then, attempts to approach the AI-enabled visual design through sketching and involves the human agents in a front-end design process, seeking an advanced understanding of the intertwined dynamics within the participatory design group.

This study is set to contribute to what is underexplored in the theory and practice of participatory design, focusing on its new relevance in a visual AI-enabled scene of front-end design. For instance, how does the group interact to communicate and internalize the problem and then create solutions with specific visual AI applications? We link the participatory design theory with the process of examining AI involvement, stakeholder engagement, and creative design interfaces for non-human subjects. Past cases by Verganti et al. (2020) demonstrated that AI reshapes design practices focusing on solving problems. Nevertheless, few have investigated the dynamics and characteristics of AI usage on different stakeholder engagement and the different perceived roles of AI agents in the front-end design space where creativity and imagination issues matter the most (Wetzels, 2021). Dated back to the 1980s, stakeholder theory (Donaldson and Preston, 1995), which defined stakeholder engagement as "a stakeholder's [cognitive, emotional, and behavioral] resource endowment in his/her role-related interactions, activities, and/or relationships" (Hollebeek et al., 2022, p. 328), presents a key issue to boost stakeholder communication/collaboration in digital environments (e.g., Viglia et al., 2018). Since stakeholders differ in their needs and roles as internal stakeholders (e.g., focal designer or team member) or external stakeholders (e.g., customer or users) in the participatory design group (Freeman, 2010), studies on stakeholders' engagement in different participatory contexts with specific AI-enabled (visual) applications have been scarce. In response, the renewed interdisciplinary methodological focus in this study holds the original contributions to enhancing the front-end design process through the scientific exploration of the

perceived roles of a specific AI (visual) agent, the stakeholders' engagement or communications in different participatory contexts, and their impact on ideation performance for non-human subjects. It also has practical implications, such as how to engage with visual AI together with participatory design for creative outcomes.

This study explores multiple real-world cases in our laboratory settings, where the conceptual model (i.e., Figure 1) has been instrumental in studying interaction modes between humans and visual AI. In this study, we conduct experiments within the controlled environment with novice designers, sketch AI, and potential stakeholders. The experimental data help unveil which perceived roles of the AI agent matter and how AI-enabled visual communication facilitates stakeholder collaborations in the participatory process of ideating for non-human subjects. Ultimately, this study acknowledges the research limitations and encourages further research and practical implementation of these methodologies to shape the future of visual-based communication in creative design.

Materials and methods

This study employed an exploratory, experimental approach. According to Schön (1984), an exploratory experiment is "when an action is undertaken only to see what follows, without accompanying predictions or expectations" (p. 144). This experiment was set to openly explore the creative design actions of the participatory design group, which was ideating for non-human subjects. Given the evolving phenomena and nascent theoretical underpinnings of our research inquiries, we embraced the design logic in research (Stompff et al., 2022). As such, research inquiries are also practice-led design inquiries that account for the development of induced theory, aspiring to be "provisional, aspirational, and contingent" (Gaver, 2014). The experiment was designed to reach contextual evidence and derive insights based on the conceptual model of activities (Figure 1), which assembles the core quality of research through design (Prochner and Godin, 2021). Drawing from Dewey's pragmatism logic to "purposefully introduce changes which will alter the direction of the course of events" (Dewey, 1929, p. 81), the inquiries regarding participatory design groups with both human and AI agents were addressed in the form of designed interventions in their formation (Halse and Boffi, 2016). The purpose of this experimental design not only corresponded to key research inquiries in terms of perception inherent to the visual AI and stakeholder engagement dynamics during the participatory process but also to create new knowledge. The perceptions of the visual AI and different types of stakeholders could be viewed as behavioral choices by a human agent and, thus, possibly modified and intervened (March, 1978). The new knowledge could be raised in the dynamic interplay of a human agent's actions and responses under the intervened contexts by adhering to the process: "we undergo a situation, act upon it, and reflect on outcomes" (Stompff et al., 2022, p. 3). In other words, the experiment was designed for observable evolving situations through interventions and to study the pathways of actual actions and their impact. It is plausible for "an experiment of finding out what possible lines of action are really like (..) in a dramatic rehearsal (in imagination) of various competing lines of action" (Dewey, 1922, p. 190). The corresponding analysis across the contexts can reflect on outcomes and help learn how to act for more creative ideation performance.

TABLE 1 Contexts of the experimental setting.

Experimental contexts	AI treatment	Human treatment
Context 1	Tool	N/A
Context 2	Creative partner	N/A
Context 3a	Tool	Internal stakeholder
Context 3b	Tool	External stakeholder
Context 4a	Creative partner	Internal stakeholder
Context 4b	Creative partner	External stakeholder

Experimental setting

The experimental setting was undertaken as a controlled environment, which minimized external influences on the study's outcomes. The setting reflected the intended experimental design to assess the interplay between humans and AI agents within the participatory design group. It configured the key environmental conditions regarding the group formation, the contexts in which the group is acting, the tasks to perform, and the population of participants. Through designed interventions, the controlled environment was set for its validity, replicability, and reliability with respect to small-scale design experimentation (Cash et al., 2012; Stompff et al., 2022).

In the participatory design group setting, the visual-based AI agent is the sketch AI (i.e., autodraw.com, Alphabet Inc.) designed for collaborating with human agents. This is because, once an input of any sort of sketch is provided by a participant, simple or complex, AutoDraw can predict and generate what is believed to be relevant computed shapes and sketches simultaneously as options for the participants to use. The setting involved the target participants due to its accessibility, importance to the homogeneity, and relevance to the research inquiries. The participants were recruited among graduate students aged 25–35 years from a top European university. The inclusion criteria also included the ownership of an animal or a plant or having a history of taking care of either one. The initial candidates were further filtered to include only novice designers, participants who have never professionally worked in design and have never used AutoDraw before. Qualified participants were randomly allocated to one of the six contexts shown in Table 1. In Contexts 1 and 2, participants were given a single intervention to perceive the AI agent as either a tool or a creative partner, respectively. In Contexts 3 and 4, participants were given two interventions: one for the perceived role of the AI agent and the other for the stakeholder role of other human agents. Herein, the participants were randomly assigned roles as either a teammate to the focal designer (as the representative of internal stakeholders) or a customer (as the representative of external stakeholders) when joining the participatory design group.

TABLE 2 Tasks of the experimental setting.

Experimental tasks	Description	Time (min)
Stage 1	Identify a problem of interest to the participant related to taking care of non-human subjects (e.g., plants, animals)	5
Stage 2	Generate as many solutions to the problem as possible	5
Stage 3	Select the best solution proposed	2
Stage 4	Recombine the ideas/Improve the selected solution	5

The task setting for the participatory design group is aligned with the four designer activities in the conceptual model (Figure 1), which aims to create good ideas for non-human subjects. According to the conceptual model, the designerly activities, including problem identification, initial ideation, (best) idea selection, and idea recombination/improvement, are indexed as Stages 1–4. The descriptions of the tasks were specified. The tasks for each context were the same and included four timed stages, as shown in Table 2.

Data collection and analysis

The experiment was conducted over 2 months in early 2024. With the pre-approval of the Norwegian Social Science Data Services (NSD), informed consent was obtained from all participants. Data collection procedures were conducted in accordance with the ethical standards of the NSD. To ensure confidentiality and privacy, all data were anonymized and stored securely. Participants were informed of their rights to withdraw from the study at any point without any consequences.

All participants received a context description regarding AI and/or other human participants and the tasks. Each group was given a tablet with AutoDraw to sketch and capture their solutions, with a brief orientation to its usage beforehand. The orientation was implemented to mitigate the likely biases regarding different levels of exposure to the increasing wave of AI among the participants. The implemented strategies to mitigate potential limitations in data collection also included the strict experiment setting, the random allocation of the participants, questions of background information, self-reporting of experience with AI, and stakeholder communications.

Furthermore, the key metrics from the experiments were recorded for data collection and analysis. Each experimental context was run three times with different participants. In total, there were 18 groups for the six contexts, involving 30 participants. The participants comprised 14 female and 16 male students with bachelor's or postgraduate degrees in various domains. Data were collected during the entire experiment via video recording, and sketches were saved on the tablet. Each participant completed the survey at the end of the group's sketching activities. Video, survey, and sketch data were all analyzed. The primary outcome measures included self-reporting of their experience in the surveys. The video data were coded to identify behaviors among the interactions between the agents. The sketches were used to validate survey responses. The cross-context analysis was employed to inform the primary experimental results. With a small sample size of three groups per context, the cross-context analysis was important to limit performance variability across the three groups. This qualitative analysis enabled an in-depth understanding of the experimentation data by identifying and discussing the cross-context differences in actual actions and impact in detail. The overarching themes aligned with the designed interventions have led us to structure the analysis to answer the following research inquiries.

TABLE 3 Problem identification and ideation output.

	Problem (non-human)	No. of ideas
Context 1 (AI as a tool)	Animal	9
Context 2 (AI as a partner)	Animal, fictional character (animal), and alien (animal)	12
Context 3a (AI as a tool)	Animal	12
Context 3b (AI as a tool)	Animal	9
Context 4a (AI as a partner)	Animal and plant	11
Context 4b (AI as a partner)	Animal and plant	8

Results

The perception of visual AI and the ideation output

Based on the observational data, most of the participatory design group chose a problem close to their life experience about animals or plants, and only a few chose fictional characters or aliens. The design sketches the group generated were commonly treated as a proxy for capturing the externalizations of ideas in a tentative form toward a solution (Paay et al., 2023). The total number of generated ideas by the groups in each context is summarized in Table 3.

The above data in Contexts 1 and 2 reveal that the perception of the AI agent, either as a tool or a creative partner in the controlled environment, is most likely to impact the ideation outputs. The video and sketch data from the video also disclose that individual designers are more engaged in working with AI in Context 2 (AI as a creative partner) and have more creative ideas in comparison to those in Context 1 (AI as a tool). However, when the potential stakeholders joined the participation design group, the scenes of the front-end design collaboration became more complex. While engaging the visual AI as a tool, ideation outputs by the groups with internal stakeholders (Context 3a, the other focal designer as a teammate) outperformed those by individual designers (Context 1) but not the groups with external stakeholders (Context 3b, the customer). While engaging the visual AI as a partner, neither groups with internal nor external stakeholders (in Contexts 4a and 4b) generated more ideas than individual designers (Context 2).

Moreover, the groups' performance in the process of engaging AI as a tool (Context 3a or 3b) is seemingly indifferent from those that engaged AI as a creative partner (Context 4a or 4b). It is questionable to what extent the groups in Context 4a and 4b managed to engage AI as a creative partner instead of a tool, as several groups reminded themselves in the later stage about this setting in the video footage. Regardless of the perceptions of AI, among those groups with stakeholders, we found that the involvement of an internal stakeholder (a teammate) created more ideas than the ones of an external stakeholder (a customer). This result could pertain to stakeholder engagement and their interactions with the visual AI, which are further explored in the following analysis.

The dynamics of stakeholder engagement and the role of AI-enabled visual communication

Based on the recorded videos, the groups' behavior interactions focusing on AI usage are coded for each task (Stages 1–4, see Table 2) in the experiment. Table 4 summarizes the interaction between the focal (novice) designer and the AI agent in Contexts 1 and 2. The observed interactions were regarding whether and how many novice designers used the visual AI to sketch their thoughts and ideas and/or used the sketch components that AI suggested in their front-end design activities, respectively. As a result, it was found that the degree of interaction between the novice designer and the visual AI agent was much higher in Context 2, where AI is perceived as a creative partner instead of a tool in Context 1. In the design process, novice designers commonly use visual AI as a sketching and viewing interface. The high degree of interaction also appeared in the later stage of idea recombination or improvements in both Contexts 1 and 2. In Context 2, most novice designers used AI suggestions throughout, except during idea selection.

Across the two high-level Contexts 3 and 4 (either a tool or a partner), we did not find a clear difference in AI usage by the different participatory design groups. However, we identified clear variations in interactions between the focal designers and different types of stakeholders. Despite Table 5 showing nearly the same level of AI usage for sketching in problem identification (Stage 1) across Contexts 3 and 4, the adoption of AI suggestions varied across different groups within Stage 1. Similarly, all focal designers and stakeholders tended to work together with the AI agent in the later stages, but to varied extents. All of the groups used AI for sketching in the initial ideation (Stage 2), but the idea selection stage (Stage 3) was mostly dominated by discussions between the focal designer and stakeholders, likely due to the lack of chat functionality in AutoDraw. The successful adoption of AI suggestions was most likely to happen in the later stage of idea combination and improvement (Stage 4).

Based on the video-recording data, the common interactions between a focal designer and an internal stakeholder (teammate) were identified. They started by discussing and agreeing on which non-human subjects or problems to focus on and then generally acted on sketching the problem. The data revealed that most of the focal designers and internal stakeholders built on each other's ideas, and most of them took turns using AI to sketch and add AI components, with one exception, that was, both teammates would like to sketch simultaneously. The interactive sketching pattern while discussing in this group yielded the highest number of ideas than others in the same context (Context 4a, AI as a partner). Generally, the feedback from the internal stakeholders to the focal designer occurred interchangeably with the sketching activity at every stage.

TABLE 4 The interactions between a novice designer and the visual AI agent.

	Front-end design	Focal designer
AI as a tool	Stage 1	Two of the three used AI for sketching; none used AI suggestions
	Stage 2	All three used AI for sketching ideas; only one used AI suggestions
	Stage 3	All used AI to view past sketches
	Stage 4	One used AI suggestions; another used AI for sketching
AI as a partner	Stage 1	All used AI for sketching; two out of three used AI suggestions; one used AI for all the components of the sketch from AI suggestions
	Stage 2	All used AI for sketching ideas; one used AI suggestions
	Stage 3	All used AI to view past sketches
	Stage 4	All used AI suggestions for sketching the idea

In Contexts 3b and 4b, which involved the external stakeholder (customer), the customer mostly suggested the design problem in Stage 1. Nevertheless, the focal designers took the lead in the later stages while the customers provided feedback alongside. Whether to sketch and sometimes who to sketch were apparent discussion topics between the focal designer and customer, starting from Stage 1 and spreading out in later stages. In most cases, we found the focal designer to sketch, and the customer only added suggestions by engaging in discussions afterwards. In many cases, while the focal designers were sketching, the customers looked away or even used their cellular phones for unrelated activities. As such, the interactions and communications with external stakeholders were limited compared to those with internal stakeholders in the AI-enabled visual design. This reduced engagement with external stakeholders is more consistent with a known design meeting for feedback instead of active co-creation.

Furthermore, we examined the survey data for self-reported experiences by the participants, including both focal designers and stakeholders. With a focus on interactions with the visual AI agent and stakeholder engagement and communication, the key self-reported experiences are summarized in Table 6.

The survey data confirms that the formulated perceptions of the AI agent's role altered the focal designers' experience while interacting with inputs from AI. Under the premise that AI is a tool (Context 1), the focal designers reported no positive experience with the generative functions of the AI agent. However, in the context of AI as a partner (Context 2), the

TABLE 5 The high-level interactions between the conventional participatory design group (including focal designer and stakeholder) and the visual AI agent.

	Front-end design	Focal designer and internal stakeholder (teammate)	Focal designer and external stakeholder (customer)
AI as a tool	Stage 1	All used AI for sketching; two groups used AI suggestions (one fully, the other partially)	One group used AI for sketching
	Stage 2	All used AI for sketching ideas; all sought the suitable AI suggestions, yet very limited adoption	All used AI for sketching ideas; two groups used some AI suggestions
	Stage 3	One group used AI for sketching and AI suggestions	One group used all the components of the sketch from AI suggestions
	Stage 4	All used AI for sketching; two groups used some AI suggestions	All used AI for sketching; two groups used AI components (one fully, the other partially).
AI as a partner	Stage 1	All used AI for sketching; two groups used AI suggestions, yet very limited	One group used AI for sketching, and some AI suggestions
	Stage 2	All used AI for sketching ideas; one used some AI suggestions	All used AI for sketching ideas and AI suggestions
	Stage 3	No use of AI	One group used AI for sketching, sought but no adoption of AI suggestions
	Stage 4	All used AI for sketching; one group used some AI suggestions (the other attempted but found no relevance)	All used AI for sketching; one group sought but no adoption of AI suggestions

TABLE 6 The key self-reported experiences for AI usage and stakeholder engagement.

	AI as a tool	AI as a partner
Focal designer	"..used as a normal sketch app for quickly visualizing concept." Viewing the suggestions as a "waste of time."	"..made it easier to draw something that would be understood by others, especially for more complex structures." "..a little frustrated having to use it for the first time." "..fun and interesting to see what it identifies based on drawings."
Focal designer and internal stakeholder (teammate)	"AI is not so helpful..on average not used much." "..working with the other designer is helpful.."	"a fun experience..a bit frustrating when AI did not pick up what we tried to draw." "a useful tool, in terms of quickly drawing desired objects.." "Good, it gave us suggestions for different figures." "Good communication (with internal stakeholder) and AI wasn't really used while communicating."
Focal designer and external stakeholder (customer)	"It was great for visualization!" "easy to use..helps productivity" "gives more ideas.. helps me to be more creative." "fun object to use.. great for visualization.. and recombination."	"Fun..too few AI versions of pictures to choose from." "It was more than a basic designer..the designs were mostly interpreted correctly except sometimes when complex shapes were combined." "..very good for recognizing the simpler stuff, but at the same time, it didn't recognize stuff like birds." "Relatively easy.. understood each other." "..the customer had too high expectations for what the AI could do."

focal designers reported mostly positive experiences with AI usage. For the contexts where internal stakeholders (i.e., another designer/teammate) were involved in the participatory process, more positive experiences appeared when AI was viewed as a partner than when AI was viewed as a tool. However, in involving the external stakeholders (customers), we found mostly positive experiences in both circumstances of AI as a partner and as a tool.

Moreover, it is consistently shown that the internal stakeholders had a higher degree of engagement than the external stakeholders. One participant indicated that working with the other novice designer as a teammate was beneficial for such creative tasks. Another participant also mentioned good (verbal) communication while collaborating with the internal stakeholder but did not use the AI agent during the communication. It is possible that the limited timeframe in the experiment affected the trade-off between communication with stakeholders and AI usage. This study's cross-context evidence shows that communication with stakeholders pressed the usage of visual AI. In the context where external stakeholders were involved, the focal designer's most common response was to meet the customers' needs, expectations, and feedback. One participant indicated that better sketching skills would help benefit more from AI usage and meet the customers' high expectations. Regardless of AI usage, the determining performance of creative ideation by the participatory design group is mostly likely associated with how the focal designer and the stakeholder interact and communicate. Looping back to the number of generated ideas (shown in Table 3), the groups with internal stakeholders (Context 3a or Context 4a) outperformed the ones with external stakeholders (Context 3b or Context 4b). Therefore, in the visual-based AI design, the higher performance of front-end design benefits from the higher-degree engagement and more collaborative behaviors within the participatory design group instead of responsive behaviors from one human agent to the other.

Discussion and conclusion

This study contributes to the growing international community of scholars and practitioners engaged in participatory design practices beyond humans in the AI age. In particular, it advances the conceptual development of AI–stakeholder engagement and creative design interfaces through the lens of participatory design. It illustrates a research inquiry through pragmatism-based experiments in real-world situations (Dewey, 1922). The core of the experiment involves interventions designed around the involvement of a visual AI agent and stakeholders, which is based on literature-supported reasoning and the participatory design research model (Dewey, 1929; Wilkinson and De Angeli, 2014). New knowledge emerged from the cases in the experiment, which were self-reported, observed, and reflected upon in terms of participants' actual actions and experiences (Dewey, 1938; Stompff et al., 2022). This study thus offers a more holistic perspective that challenges participatory design-related traditions solely centered around users and designers.

The results presented have direct implications for engaging with visual AI and stakeholders, ultimately influencing the potential creative performance of every designed product or service for non-humans. This study is the first to present evidence that the human perception of a visual AI agent has a major impact on creative performance. Specifically, it was found that the human perception of AI's role, whether as a tool or as a creative partner in an experiment, matters. The preferred perception of the AI agent as a creative partner can be fostered in the working environment. Moreover, the identified differences in engagement levels and interactive behaviors provide insights for managing the participatory process when different types of stakeholders are involved. Higher levels of stakeholder engagement and collaborative interaction between stakeholders and focal designers are recommended for more creative outcomes. Potential differences in visual AI-based teamwork experiences were observed in relation to the perceptions of AI agents' roles. However, we did not find critical instances of those different roles that visual AI plays in the development of stakeholder engagement and communication in this study.

It is worth mentioning that this explorative study has a limited scope, such as using a specific visual AI, involving a participant pool of novice designers, and investigating only two types of stakeholders (i.e., teammate and customer) in the participatory process of front-end design. However, the conceptual model and method proposed in this study could serve as a foundation for future studies. For instance, additional studies could be conducted to determine whether similar findings hold in a more longitudinal setting and involve experienced designers. A greater number of characterized stakeholders (e.g., with different business functions in organizations), diverse forms of AI-enabled design applications (e.g., verbal, text, video, etc.), and subsequent design activities after the front-end design phases (e.g., prototyping, testing, etc.) also warrant further exploration. Further understanding of the role of an AI agent in influencing perceived tensions, vulnerabilities, and consequences, whether for different types of stakeholders, as well as in optimizing strategies for designing better AI-based stakeholder engagement and their responses to one another, can be valuable for future development.

Data availability statement

The datasets presented in this article are not readily available because the observational videos potentially contain identifiable data, thus not being possible to share. Part of the data (i.e., survey data) is shareable without identifiable data. Requests to access the datasets should be directed to YYZ, yangyz@uio.no.

Ethics statement

The studies involving humans were approved by NSD (Norwegian Center for Research Data). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

YYZ: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing, Validation.

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When we talk about time, we mean many different things: employing visual mapping to think through more-than-human temporalities in participatory design

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In recent years, the scope of participatory design has broadened to encompass perspectives and approaches beyond the human realm. This expansion requires considering multiple aspects to fully capture 'more-than-humans' diversity and concerns. One approach to tackle this multifaceted challenge is by examining it through the lens of time. However, the temporal dynamics of more-than-human entities remain relatively unexplored within participatory design. This paper investigates the potential of visual mapping to aid stakeholders engaged in participatory design processes that incorporate more-than-human perspectives in navigating the complex dimensions of more-than-human time. The findings demonstrate how visual mapping can facilitate thinking beyond linearity, developing awareness of workshop-related temporality, making time concrete, understanding the 'far lense' through the 'near lense', comprehending time's relationality, unfolding time and considering multiple timespans simultaneously. Based on these findings, the paper suggests that visual mapping can help understand more-than-human temporalities in participatory design by thinking through them as a reflective practice.

KEYWORDS

participatory design, more-than-human, temporality, visual mapping, visual communication, research through design (RtD), non-anthropocentric design

1 Introduction

In recent years, due to the global environmental crisis and the realization that design plays a decisive contribution to climate change and the ongoing extinction of other species (Wakkary, 2021; Laurien et al., 2022), participatory design has started to embrace entities such as rivers, forests, weather systems, animal flocks and viruses as subjective and political actors. The idea of multi-species justice (Celermajer et al., 2021) and the understanding that human existence is intertwined with the lives of other beings (Haraway, 2016) enable the emergence of new relations and dynamics in the participatory process from a position of humility and care (Akama et al., 2020; Bridle, 2022), paying attention for more-than-human entanglements and interdependencies (Laurien et al., 2022).

Involving more-than-human actors in participatory design processes requires considering multiple aspects, including their "diversity, disagreements and overlapping concerns" (Wakkary, 2021, p. 212). Capturing the full complexity and multifold dimensions of more-than-humans is an overwhelming task. Smitheram and Joseph (2020) argued that to expand a more-than-human approach in participatory design, we must consider different ontological perspectives and emergent methodological approaches. One way to address it is through the lens of time (Rose, 2012). Considering multiple temporalities related to more-than-human actors - such as the generations of living things, ecological time, synchronicities, intervals, patterns, and rhythms (*ibid*), expressed in, for example, "the turning of the seasons, the continental migration of birds, the lifespan of trees and plants" (Bridle, 2022, p. 118) - can facilitate understanding their perspectives and context of life (Mareggi, 2013), and enable us to understand more fully design processes grounded into the complexity of these ecosystems.

However, we seldom think through temporal diversity (Rose, 2012). Del Gaudio et al. (2017, p. 114) point out that "participants and space have often been the subject of research activities, while time has always received far less attention." Saad-Sulonen et al. (2018, p. 5) relate to temporality in participatory design by saying that, although such interest exists in numerous other fields (e.g., organizational studies, anthropology and interaction design), participatory design is "still far from having an established time-sensitive discourse."

In this paper, we will explore how visual mapping can help stakeholders involved in participatory design processes that embrace more-than-human perspectives to think through multiple dimensions of time beyond the human and understand their relationality. We see 'thinking through' as a reflective practice aiming for a more thorough and careful understanding and entailing a sense of directionality, a closer engagement with materiality and a more nuanced, detailed and multilayered view of time. As such, the idea of 'thinking through' can be considered as opposed to routinely schematic and reduced considerations of time, which take into account already familiar knowledge. Our study is grounded into some design experiments in the form of participatory design workshops, which were carried out between 2023 and 2024 in Denmark and Sweden.

The structure of this paper will be as follows: In Section two, we review existing literature according to the categories 'visual mapping', 'temporality in participatory design' and 'more-than-human perspectives in participatory design'. Section three explains the methodology in use. Section four presents the workshops' main findings. Section five contains the discussion and articulates the paper's main contribution. Section six presents some final remarks.

2 Literature review

2.1 Visual mapping

This paper departs from the map definition as "a diagram or other visual representation that shows the relative position of the parts of something" (Merriam-Webster Dictionary, 2024). The first part of this interpretation highlights the depictive role of the map as an artefact and its function as an output. Its second part articulates the maps' fragmental and relational quality. Examples of such maps used in design processes are actor-network mapping (Morelli and Tollestrup, 2007), which provides a broad overview of the network of actors and components in the system, context mapping of social, cultural, environmental and economic realities by local knowledge holders (Sarantou et al., 2021), time-based diagrams (Sevaldson, 2004), which show action sequences in service, and motivation matrices, which display the functional relationship between all the actors participating in a production system (Morelli and Tollestrup, 2007). These maps generally function as a rhetorical device (Propen, 2007) to convey a message.

Other visual mapping techniques associated with this definition aim to capture a higher level of complexity by emphasizing multiple parts of the depicted topic and acting as analysis tools (Doyle et al., 2024). Thus, they can serve as a boundary object to facilitate research (Harvey, 2024) and unfold different problem dimensions (Irwin, 2015). Examples are mental model maps that make implicit knowledge visible (Doyle et al., 2024), Giga maps (Sevaldson, 2011), which frequently serve as a repository of information, giving stakeholders access to existing knowledge across multiple layers and scales, examining relationships between categories, and critically framing the system (Jones, 2014), or synthesis maps (Jones and Bowes, 2017), which incorporate multiple layers and scales into one visualization. Designers use these maps to synchronize and coordinate a situation from a multistakeholder perspective (Harvey, 2024), articulate relationship configurations, amplify plurality, and elaborate complexity. Therefore, they could be read in various ways and do not convey a single message.

In this paper, we focus on visual maps created and used in participatory design. Both 'participatory' and 'visual mapping' refer to well-established disciplinary frames. However, brought together, they give rise to a different practice mode. Yet, the term 'participatory visual mapping' is not consolidated in design literature and practice, and the few mentions in the literature mainly relate to various visualisation techniques. For example, within the context of participatory design, Gaudion et al. (2015) use visual mapping and photographic imagery to design questionnaires; Vrancken (2018) employs it when describing a figure to represent soil diversity, and Buur et al. (2013) consider it when describing a value flow model created to support a team discussion. Visual maps used in participatory settings are often process-oriented, unlike maps that function as outputs and are often characterised by compelling visual images with rhetorical power (Kitchin and Dodge, 2007). These process-oriented maps focus on mapping as a practice of shared thinking that stakeholders use to explore and construct conditions and relations, aiming to reach a more nuanced understanding of complexities by creating spaces for conversation, augmented sensorial awareness and explorations (Pollastri et al., 2021). As such, they are not fixed but in a constant state of becoming (Kitchin and Dodge, 2007; Dodge et al., 2011). In this map type, the distinction between production and application, producer and user, is blurred (Grootens, 2021).

To suggest a more nuanced understanding of the different types of mapping, we turn to the paper Visualisation and Cognition: Thinking with Eyes and Hands by Latour (1986). Latour allows us to look closely into the purpose behind the act of drawing things

together, which we interpret here as 'participatory visual mapping' and points out two approaches to mapping by telling the story of the French explorer La Pérouse, who travels through the Pacific to bring back a better map. During this journey, La Pérouse arrives at Sakhalin in China and tries to learn from the locals, whether it is an island or a peninsula. To help him, an older man draws a map of his island on the sand with the scale and details that La Pérouse needs. A younger person sees that the rising tide will soon erase the map and picks up one of La Pérouse's notebooks to draw the map again with a pencil. Latour discusses the differences between the two maps. He concludes that what is, for one, a drawing of no importance that the tide may erase is, for the other, the object of his mission. The older Chinese person, he writes, does not have to keep track since he can generate many maps at will, being born on this island and fated to die on it. La Pérouse, on the other hand, is just an occasional guest aiming to visit and take something back and, therefore, needs the map as a portable object.

The first approach to mapping is situated, temporal and process-oriented. The Chinese person creates the map to answer a question. He does not consider it an object meant to last or function outside the encounter. Therefore, he uses materials from his immediate environment to facilitate a conversation and does not care for them to last. The temporal frame is present, responding to *ad-hoc* needs and subjected to the earth's rhythm. In contrast, the young man is interested in mobilising the information for the future and sharing it with others outside of the momentary encounter. To do so, his artefact must contain "absent things presented all at once" (p. 8). Latour explores this proposition, providing us with instructions for what we could consider a visual communication approach to map-making: "The "things" you gathered and displaced have to be presentable all at once to those you want to convince and who did not go there. In sum, you have to invent objects which have the properties of being mobile but also immutable, presentable, readable and combinable with one another." (p. 7). The map created by the young man becomes a vehicle to stabilize and transfer knowledge into new contexts and further time.

Through the story, Latour explains maps' traditional visual communication role as a "transferable form of knowledge that is portable across space and time" (Kitchin and Dodge, 2007, p. 15). Thus, maps can enable actions at a distance and consolidate information to become part of Western scientific knowledge aiming at making true claims about the world (*ibid*). Nevertheless, Latour recognises that a different approach also exists by mentioning alternative ways of mapping. Indeed, 40 years after he wrote this text, participatory design adopts this proposition by approaching mapping as a situated, momentary, and relational practice (Kitchin and Dodge, 2007). In practice, designers tend to blend the two approaches to co-create situated knowledge and share it with others outside of the momentary encounter.

This is also the case when mapping multiple temporalities. Hayes et al. (2021) invited participatory designers to capture and combine differing temporal perspectives in a final design outcome. They highlighted the importance of articulating them visually, allowing the views to correspond to each other to provide opportunities for mutual learning, knowledge exchange, discussion, testing, and design. Similarly, Pschetz and Bastian (2018) called for designers to create artefacts and systems that disclose the variety of temporality and temporal relationships. However, the view of visual mapping as an approach to support thinking through time is generally overlooked.

2.2 Temporality in participatory design

So far, the research on temporality in participatory design has been carried out from a few angles. The first is project time (Saad-Sulonen et al., 2018). Lindström and Ståhl (2015) discuss design as entanglements in multiple temporalities during and after the project. Farías (2017) explains how project timelines create certain norms and values. Del Gaudio et al. (2017, p. 116) point out how temporal misfits might be a common situation in participatory design because "each actor's time and specific regulations may strongly influence the project's global time and respective temporal dynamics" and therefore suggest considering temporal aspects such as "local rhythm, the time required for achieving change, community participation speed and timing norms of partners."

Another angle relates to participation: (Hayes et al., 2021, p. 509) call for considering the multiplicity of temporalities among participants and "taking the temporal flow of participation into account more actively." Saad-Sulonen et al. (2018) propose five lenses that may aid researchers in exploring and understanding the temporal dimensions of participation: the phasic, emergent, retrospective, prospective, and long-term lenses.

Participatory design also approached temporality from the perspective of extending the time lens. Here, design researchers try to stretch the participation view, including looking back, forward and more extensively into the present (*ibid*). Wakkary (2021, p. 67) relates to extending temporality into the future in participatory design through the notion of artifacts as they "operate across time from the present to the future." Thus, understanding the use of a present artifact is the analytical grounding for an imagined future use of a related artifact, assuming a continuation. Laurien et al. (2022) emphasized that many issues cannot be solved during the project's time frame or perhaps not even within a human lifetime. Few scholars dedicated special attention to the past, suggesting how working with it in the context of social-life timing (Del Gaudio, 2023) can contribute to the design process (Huybrechts and Teli, 2020; Kambunga et al., 2023; Zuljevic et al., 2023). Jönsson et al. (2021) suggested situating the problem of out-of-sync plant-pollinator relationships into a rich present rather than a distant future as part of what they call 'collaborative future-making'. Jönsson and Lindström (2022) articulated change in relation to the past so we can orient ourselves towards unknown futures. Despite these existing studies, scholars point out that participatory design research did not pay much attention to temporality aspects (Saad-Sulonen et al., 2018; Del Gaudio, 2023), temporalities are often left under-specified (Søndergaard et al., 2023), and there is still much room to go beyond traditional time dichotomies (Rapp, 2022).

Moreover, the existing time-oriented discourse in participatory design is mostly limited to a human-centered perspective and is mainly based on the related (human-centered) social and cultural context. Del Gaudio et al. (2017) defined four social-related categories of temporality in participatory design, and Pschetz and Bastian (2018, p. 171) suggest a temporal design approach to bring "cultural, social and economic aspects of time to the surface." An exception is the work

of Laurien et al. (2022), who argued that a more-than-human perspective should drive designers to work with multiple temporalities. In their work, they explored the notion of deep geological time and broadened the temporal perceptions of their participants to include the present and speculative future. Hayes et al. (2021) pointed out the need to develop an 'attunement' towards different temporalities existing in the participatory design process as they generally remain under study.

2.3 More-than-human perspectives in participatory design

The history of participatory design is human-oriented. It emerged in the 1970s in Scandinavia from systems design to counteract the dehumanising effects of an increasing technological presence in the workplace (Ehn, 2008), with the intention to involve and empower a broad range of stakeholders in decision-making processes as co-designers (Lindström and Ståhl, 2015; Wakkary, 2021). Over the years, participatory design has shifted towards sustaining and developing communities of participants exchanging skills and knowledge to arrive at a process of designing together and addressing their concerns (Wakkary, 2021). Methodologically, participatory design often uses workshops, interventions, art-based methods and prototyping to facilitate participation in the design process (Jönsson et al., 2021; Pietarinen et al., 2023). As part of its inclusive approach, participatory design promotes the involvement of people without a voice and power, e.g., from marginalized and vulnerable groups like youth, people with dementia, autism and others (Akama et al., 2020; Pietarinen et al., 2023).

In recent years, issues like climate change, biodiversity loss, and increasing extinction rates have created conditions for explicitly including nonhumans on the participatory design agenda (Bastian, 2017), responding to Latour's (2004) opinion that both humans and nonhumans have the right to speak. Participatory designers have increasingly reflected on expanding participation to incorporate more-than-human actors' perspectives in design processes (Haldrup et al., 2022), acknowledging that human and non-human actors have equal agency (Miettinen et al., 2022). However, how to understand the relations between humans and more-than-humans is under debate. Some participatory design streams tend to contrast the two groups (Andersen et al., 2015). Rice (2018), for example, distinguishes between humans, who can take actions affecting something, whom she defines as participants, and more-than-humans as "entities that do things," which she relates to not as participants but as 'actors'. A different approach, represented by design researchers such as Akama (2015), Laurien et al. (2022), and Romani et al. (2022), perceives participatory design as a discipline that should alter the boundary between participating and 'not' participating in a non-hierarchical manner. They emphasized our relations, inseparability, and entanglements with more-than-humans and question the context in which the exchange of ideas and interests happens (Sachs Olsen, 2022). Fundament to this debate is the issue of language. Bennett (2010, p. 107) suggested "loosening the tie between participation and human language" to encounter the world "as a swarm of vibrant materials entering and leaving agenic assemblies." Other researchers explored the participant's role as a 'spokesperson' (Sachs Olsen, 2022) or 'speaking subjects' for and on behalf of nonhumans (Wakkary, 2021).

To date, participatory design researchers explore more-than-human approaches from three main angles: methodology, materiality and participation. From a methodological perspective, Laurien et al. (2022) stress the importance of embodiment as a bodily and sensorial engagement, also present in the work of Haldrup et al. (2022, p. 15), "draw from sensing, observing and doing." Artistic and aesthetic representation that showcases and represents what we cannot see is another methodological approach presented in their work and in the research of Sachs Olsen (2022). The equipment and materials used as design tools, identified by Laurien et al. (2022) as a core denominator connecting design and more-than-human approaches is the focus of other researchers (Rice, 2018). A third stream of research focuses on more-than-human participation, like in the case of Laurien et al. (2022), who substituted pollinators to indicate their potential future absence in the pollination of clover plants. Nevertheless, more-than-humans have been relatively under-researched in participatory design, and the focus remained largely human-centered (Palmås and von Busch, 2015; Clarke et al., 2019).

There is an agreement among participatory design researchers that expanding more-than-human approaches is much needed for the sake of the field itself to develop a fuller understanding of participatory design (Rice, 2018) and as a means towards more significant goals such as forging our thinking and practice (Akama et al., 2020), to create "more democratic networks, formulate non-hierarchical relations, and, consequently, reflect on the more-than-human agencies and interests" (Romani et al., 2022, p. 2), "re-enchant" the commons and "pose environmental justice claims" (Haldrup et al., 2022, p. 15), and understand the impact of participatory design on more-than-human actors (Calderon Salazar and Huybrechts, 2020). Among the various more-than-human perspectives yet to be explored in participatory design is the aspect of temporalities. As discussed here, there is a lack of studies that connect participatory design, temporality and more-than-human. Thus, this paper will address this question: How can visual mapping support understanding more-than-human temporalities in participatory design?

3 The methodology

This paper is grounded in research through design. The core of research through design includes three components of the iterative work process: formulating a program, realizing through experiments, and formulating results through reflection (Redström, 2011; Löwgren et al., 2013). Binder and Redström (2006) see the program as the first framing of a design space within which possibilities can be explored through experimentation. Brandt and Binder (2007) define it as a "hypothetical worldview that makes the particular enquiry relevant." Converging the two aspects, the program refers to a set of overall intentions and aims to guide a possibly extended explorative design process (Redström, 2011; Löwgren et al., 2013).

The program depends on experiments to substantiate its propositions or proposals. In other words, it needs materialization to

10.3389/fcomm.2024.1440257

TABLE 1 An overview of the workshops.

Workshop no.	Location	Duration	Participants	Visual mapping techniques in use	Number of participants
1	The South Harbour, Copenhagen, Denmark.	5 hours	Design students	Group Flipboards, sketching, photos, strings	26
2	Folkparken, Norrkoping, Sweden.	4 hours	Design researchers	Shared canvas, Objects from nature picked by participants and organisers, photos, sketching	9
3	Amager Fælled, Copenhagen, Denmark.	3 hours	Architects	Shared canvas (outdoors), Objects from nature picked by participants and organisers, photos, sketching	4
4	Hybrid Workshop in Malmo, Sweden. Including online participants from Denmark, Turkey, Finland and Portugal.	5 hours	Scholars working with more-than-human approaches	Sketching, shared canvas on Miro board	11
5	The South Harbour, Copenhagen, Denmark.	5 hours	Design students	Sketching, group canvases, Organic materials: wooden bricks, soil, wood, bulbs, water	18

FIGURE 1
Tuning with the environment. Upper left corner and clockwise: Folkparken, Norrkoping, The South Harbour, Copenhagen, Amager Fælled, Copenhagen, Malmo Harbour.

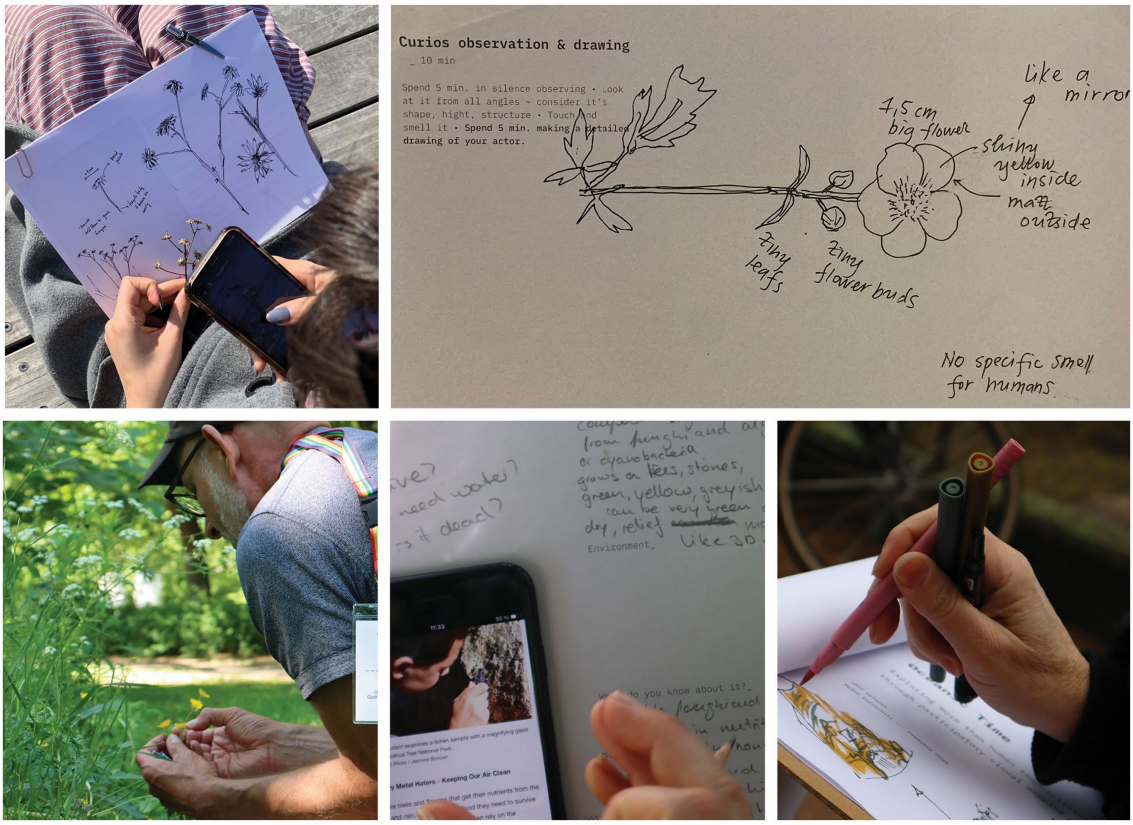

FIGURE 2
Exploring a specific actor.

make its hypothetical worldview into something 'real' (Redström, 2011). At the same time, the experiments need the program as a precise frame to provide intention and direction and ensure everything 'falls in place'. These are dialectic relationships. The experiments respond to the program's suggestion as explorative actions and form certain insights that, through reflection, make sense of early intuition and reframe the program to comprise new experiments (*ibid*). The experiments also serve as a vehicle for theory construction and knowledge generation (Bang and Eriksen, 2019).

The program described in this paper comprises five experiments in the format of workshops. Each workshop was guided by one to three facilitators, including the authors of this paper and their colleagues. The workshops took place between 2023 and 2024 in Denmark and Sweden, with 68 participants (Table 1). The initial framing of the program started from an educated intuition aiming to explore and represent more-than-human perspectives in participatory design. In early experiments, the temporal aspects were among other aspects that we explored with participants. As our research advanced, the reflections made us realize this topic was particularly interesting and we formulated the program centering the later experiments around it.

All five workshops followed a similar structure: the first part occurred in an urban outdoor area where we guided the participants through what Tsing (2015) calls the "art of noticing." In this part, we tuned in and developed attentiveness to the environment to become more sensitive and better capable of seeing, hearing, tasting, and feeling (Mol, 2010) and approach the workshop as an informal experimental space (van Dooren et al., 2016). To do so, we guided the participants through several exercises, including a listening meditation session and various forms of observation, where they took notes, picked local materials and drew sketches to collect their impressions (Figure 1: Tuning with the environment). In the case of the hybrid workshops, participants followed these activities using a digital booklet that included written instructions and audio guidelines. Then, we asked participants, individually or in groups, to pick a more-than-human actor or assemblage, observe, interact and explore it through another sequence of exercises, including curious observation and drawing, exploring actors' environment, conducting rapid online research, drawing actors' time and writing a letter to the actor in the future (Figure 2).

In the early workshops, we addressed the temporal aspect by relating to the actors' lifespan and time, writing a letter to the actor in a 100 years, and imagining what came before by drawing a timeline from the beginning of time until now. In workshops four and five, we focused on the temporal aspect, asking participants to depict actors' time through three temporal categories: actors' time in relation to the natural world, considering aspects such as seasons, tide, light and astronomy, actors' lifetime and pace. To facilitate the exercise, we asked participants probing questions such as: Is time linear or circular? In which direction does it move? Does it move at all? Is it a developing or a still situation? On which scale do you measure it? What can interrupt it?

FIGURE 3
Some of the materials we provided the participants to support the visual mapping.

FIGURE 4
Visual mapping sessions.

In the third part of the workshop, we provided participants with various materials (Figure 3) and a canvas to create a representation of the actor they interacted with. In the first three workshops, we ran a visual mapping session in which we visually represented the actors we interacted with, drew their relationships, and concluded with a discussion in which we reflected on our work. In the fourth workshop, we gathered for an online session where we shared the various temporal depictions we created on a digital Miro board, and on the fifth workshop, we asked groups of four participants to create a shared temporal depiction based on their earlier individual work (Figure 4). We concluded all workshops with a discussion among participants. As research showed that some dimensions of temporal judgement are more strongly associated with aspects of experiential perception, while others depend mostly on cognitive processes (Block, 2014; Correia, 2024), we aimed at combining the two to fully leverage participants' temporal perception. The evolution of the workshops' design was made possible through our ongoing learning from participatory observation in the workshops and from the participants' feedback.

4 Findings

The five workshops we described above expanded participants' awareness concerning several dimensions of temporality.

4.1 Thinking time beyond linearity

The workshop participants depicted time in various ways: linear, circular, and accumulated. In cases where time was pictured linearly, some sketches suggested fluid and fuzzy depictions, unlike common straight lines often associated with modern perceptions (Aigner et al., 2011) (Figure 5).

One participant reflected on how different forms can alternate with each other, saying: "As individuals, we can view our lives as linear, but if we add past and future generations, they become cyclic." Simultaneously, various other participants depicted time circularly (Figure 6).

Participants who interacted with the Creeping Buttercup flower noticed the time it was apparent above the ground and chose to represent it through the four seasons in a circular manner, not as an act of linear life and death but as a cyclical process formed by the seasons (Figure 6). A participant who observed seagulls (Figure 6) represented their lifetime as a circle of "growing, laying eggs that become young birds again." This made her reflect on the differences between the time experienced by the individual and species-related temporality, saying, "I realised this visualization is probably describing the species rather than a single seagull."

The interaction with a Water Lily (Figure 7) made participants think through seasonal time. She learned from a web search that Lilies grow under the water in the winter, but the observation made her

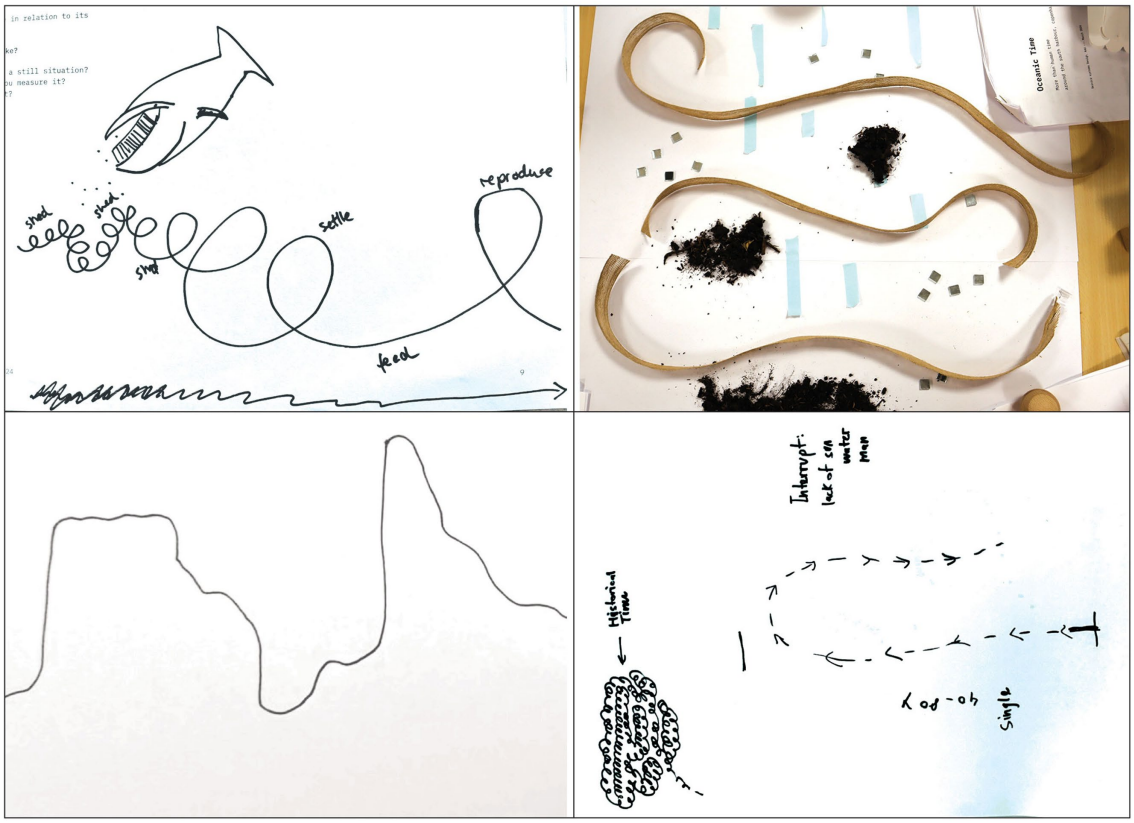

FIGURE 5
Upper left corner and clockwise: a linear depiction of time in relation to barnacles on rocks, algae, ice on soil and Weeping Willow tree.

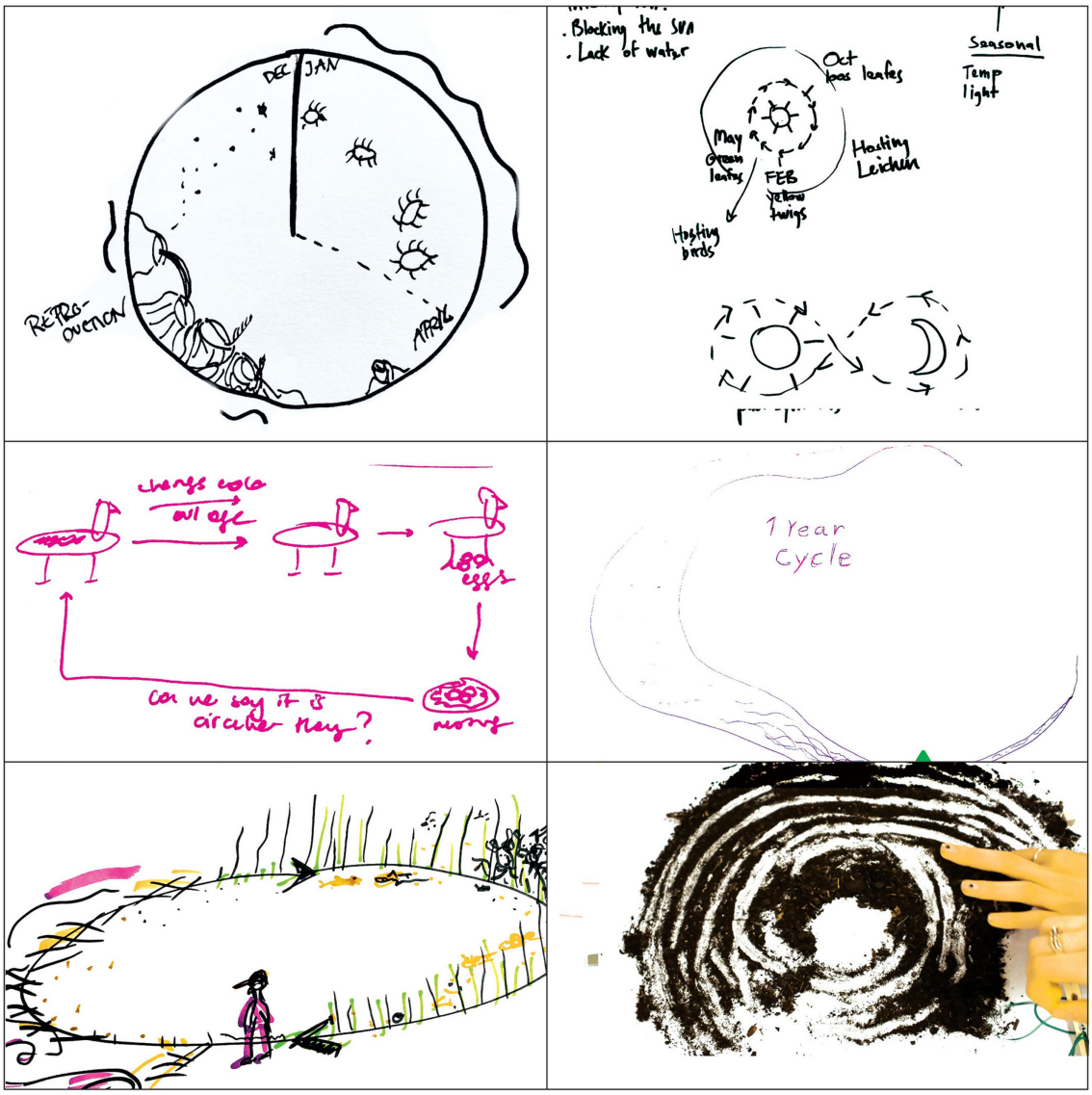

FIGURE 6
Upper left corner and clockwise: circular depiction of time in relation to barnacles, a Wipping Willow tree, a ditche, moss, *Phragmites australis* reed and seagulls.

FIGURE 7
Engaging with a water Lily.

reflect: "I cannot tell if it is the same leaf coming out every year or it is a new one after the old one dies." The participant was immersed in the interaction, trying to understand the Lily's mechanism through the lens of seasonal time.

A third mode of depicting time was accumulation (Figure 8). One participant mentioned that it is easier to relate to the circular time of other organisms as these are rhythms we share, whereas the accumulated time becomes more abstract. He added that it is also a matter of perspective and framing, as "the seasons also show themselves in accumulation: in rocks and tree rings." Another participant who depicted a time of a tower covered with moss related to the quality assigned with accumulation, saying: "It is like time falling into itself because it is so dense." A third participant reflected on the term accumulated time and suggested it can serve to describe growth in a regenerative manner since extracting from it will require a long period to reproduce.

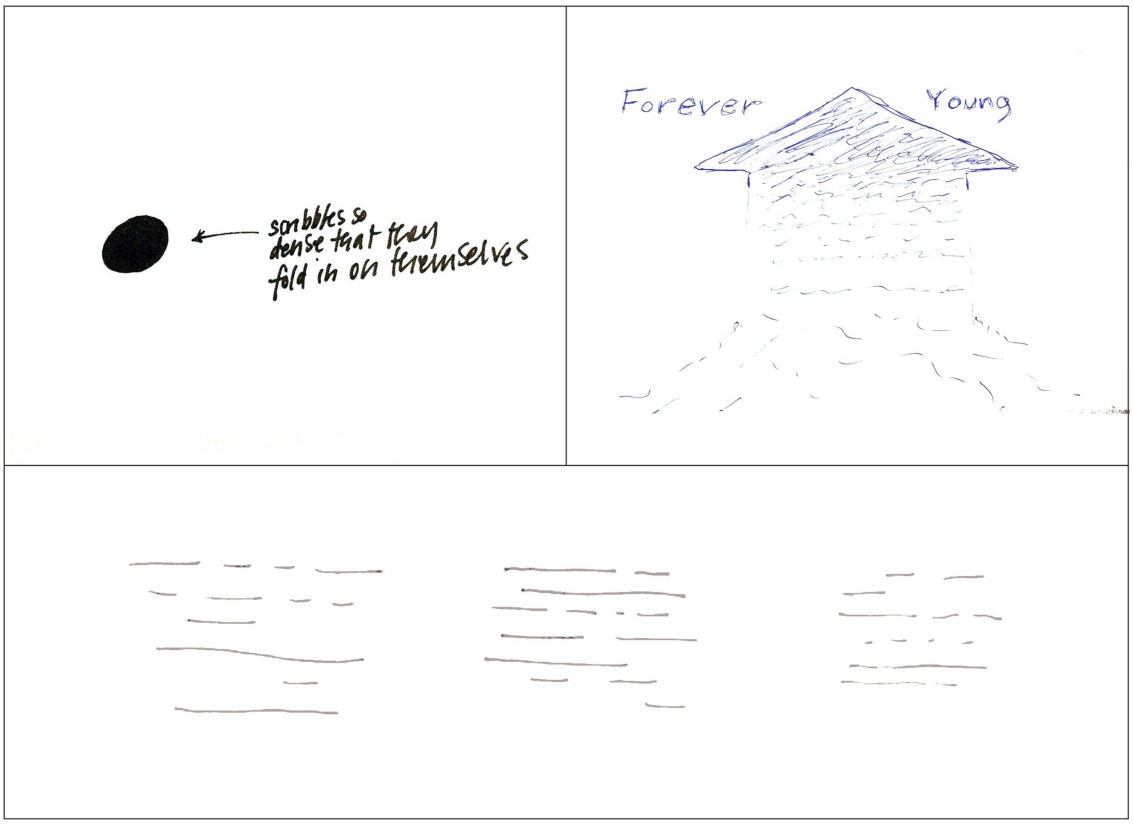

FIGURE 8
Upper left corner and clockwise: depictions of accumulated time in relation to a tower, white moss and ice on the soil.

4.2 Developing awareness of workshop-related temporality

Participants reflected on how temporality played out in the workshop setup. As each workshop lasted three to 5 hours, some said that creating a deep connection with other species requires more time and wished for a more extended engagement period, critically saying: "I wonder if quick workshops are a good format to understand these connections." Others hoped for a different interaction format to allow more time to connect, saying: "Imagine an ongoing workshop in one place for a long time…!." Another aspect of temporality in the workshop was the access to information on the participants' phones. One of the participants reflected that accessing the external stream of knowledge available on the web expands the workshop's scope beyond the here and now by including unlimited knowledge generated and collected over time. In terms of the nature and quality of their engagement, participants reflected that to notice multiple temporalities beyond clock time, one needs to change one's speed and slow down. Observing various temporal aspects such as seasonal time, stage of growth, and relations between different tempos can be reached when participants center within themselves and contemplate their surroundings. Figure 9 shows how the act of sketching facilitates and reflects the attunement to the environment by noting down small details that people commonly overlook, such as the leaf's shape, shadow on the ground or sound, and enhancing it by forcing the participant to pay close attention to details they can otherwise miss.

4.3 Making time concrete

Augustine et al. (2019) pointed out two common ways to discuss futures. The first is called 'distant futures', which are construed more abstractly and tied to broader theories, ideologies, and desired identities. The second is near futures, which are detailed and connected to sensory observation and the degree of practicality, interpreted in more specific terms and with more detailed situational elements. Augustine et al. encourage specificity and credibility as, according to them, they are assigned to a sense of plausibility and seriousness rather than mere fantasy.

While presenting the interaction with more-than-human actors and reflecting on the mapping exercise, we often apply the 'distant futures' approach by making generalizations about time and imagining more extended periods than the actual time. For example, participants assumed that the river slopes "has probably been there for millions of years" and can last forever, the oak "has been here longer than all of us, and it has been through a lot," the Creeping Buttercup flower "can stay yellow forever," and moss is "'forever young." In relation to a tower dated to 1940, a participant mentioned that "it sits out of time and is incredibly organic; it felt like it is timeless," and a nearby window "feels like it is from another time, from its own time." The research and the conversation with the other participants revealed that the slopes are likely 10,000 years old, just like the arrival of the first human to the area, the oak is probably around 60, and when we say 'yellow forever', we relate to flowers found in 200-year-old abandoned cottages. The accompanying research and the conversation among the participants

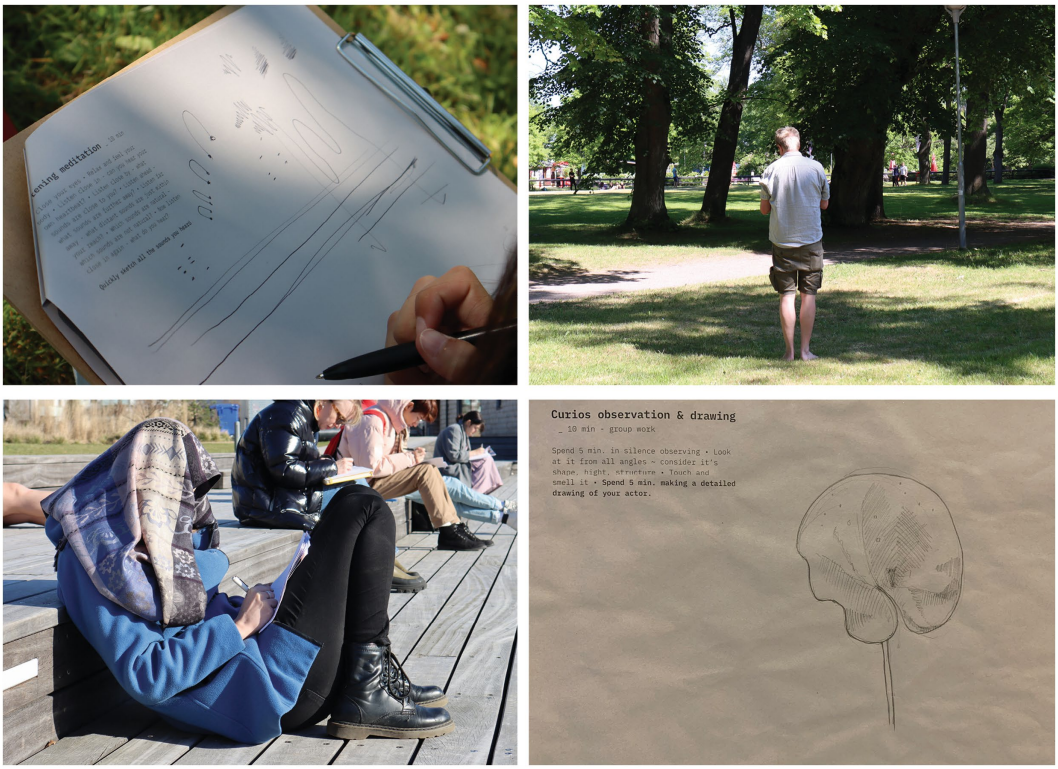

FIGURE 9
Participants adjusted to the environment and noticed details by slowing down and sitting quietly to draw visual, auditory, and sensual impressions.

allowed us to move from generalisation and guessing to more detailed and informed work.

4.4 Understanding the 'far lense' through the 'near lense'

When interacting with more-than-human lifetimes extending beyond human timescales, like those of trees and lichen, participants face the challenge of thinking into the deep past and the far future. To some extent, the visual mapping exercise helped participants overcome this tendency by identifying aspects of the individual actors by looking through the near lens and articulating how they indicate broad ecological changes likely to create a long-term impact assigned to the far lens. Thus, the near lens acted as a portal to a more extended period, and the visualization process helped to imagine the deep past and far future in detail and make it more concrete. In a few cases, participants got to think about deep time and how ecological changes unfold through interacting with the 'near lens' of individual actors. For example, following a depiction of a Cocksfoot grass, a participant expressed her thoughts about long time horizons, saying: "You cannot build over nature; time vaporizes everything. Nature will recover. If there is a crack, something will grow; if you leave an abandoned space for 20 years, nature takes over."

Another discussion emerged about Lichens growing next to glaciers. Lichens only grow on dry land, so their presence next to glaciers indicates glaciers retreat due to climate change. Observing the Cocksfoot grass placed on the canvas next to the Lichens, participants figured that another indication of climate change could be finding species typical to southern Europe, like the grass, in Scandinavia. In both cases, the near lens related to the actor indicates the far lens of ecological change. Another participant who depicted a Juniper shrubbery's pace reflected on how thinking through different scales leads to different realizations, saying that you can see how a plant reacts to a specific environment when looking at the details. Still, from a broader perspective, you interpret those changes in relation to bigger causes.

4.5 Comprehending times' relationality

The visual mapping allowed participants to understand the relational aspects of time, defined by (Tsing, 2015, p.34) as "interwoven rhythms." A sketching of a Juniper's shrubbery pace (Figure 10) led a participant to think of how it is affected by the external environment. He then realized that the plant's temporal perception is "influenced by all the time perceptions of other animals and humans that are imposing to it, like plastic bottles we drop or animals and humans seeking shelter."

Watching geese made another participant think in terms of music. She observed how various rhythms of different species come together (Figure 10), creating a composition: "The cycle of the migration can be merged with other cycles of other species, and in that way, you create a polyrhythmic pattern. It is like in music when you have several rhythms coming at the same time… it is a polyphony of multiple rhythms at the same time," she said. A participant who got engaged with seagulls mentioned her lack of ability to distinguish their

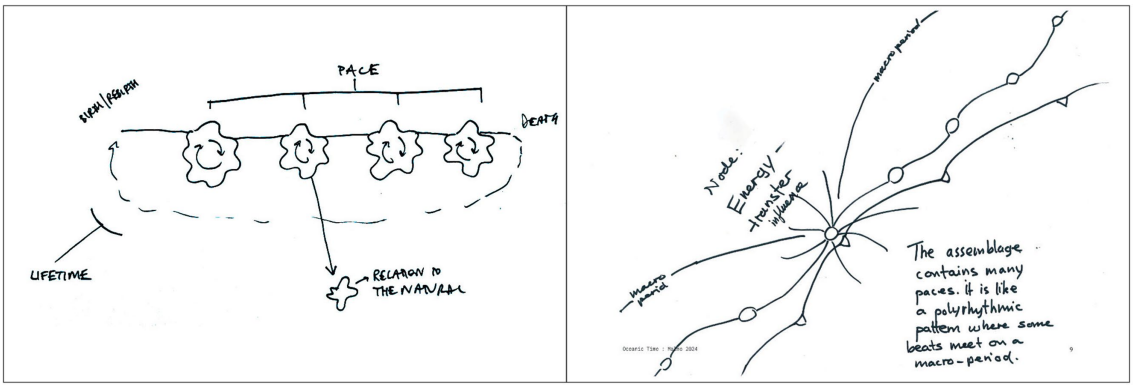

FIGURE 10
Left to right: depicting the pace of a Juniper shrubbery and geese.

FIGURE 11
Depicts two Weeping Willow trees taking the shape of a ball game with two courts.

time from other actors, as they were constantly involved "with the sea, fishermen, fish boats, and people," while a participant that observed reed expressed a similar realization, saying: "I learned there is a lot of interconnectedness between humans, reed, and species underground." She related to it as "a collective assemblage of different actors" and mentioned how the reed is dependent on cows to eat it, and humans to cut it down in autumn.

Four participants depicted a temporality of two Weeping Willow trees (Figure 11). The depiction relates to the different growing conditions of two trees, one growing in a central park area, watered and cultivated by humans. The other grew spontaneously from a crack in the pavement in a neglected spot. They chose to represent the two trees through a metaphorical ball game with two courts, where the tree is represented by a ball and the environment is represented by the court. While one environment is depicted as a smooth rail allowing fast and easy growth, the other is full of obstacles limiting it. The ball's pace results from the relationships between the trees and their environment. Similarly to Latour's (1997) description of different train rides and how they are a result of interactions and relationships, "the difference between our two voyagers comes from the number of others one has to take into account, and from the nature of those others" (p. 176). One of the participants reflected on how the pace is an outcome of the relationship of the trees with their environment: "These are trees in a garden controlled by humans, so we chose to depict it linearly. It would have looked different if it had been in a forest," she said.

4.6 Unfolding time

The visual mapping supported participants in unfolding the notion of time, becoming aware of its richness, plurality and multiplicity. One participant referred to the work of Haraway (2016), saying: "You get to understand there is so much accumulating, so it is like personhood or timehood. Haraway talks about 'thick presence', but there is also some richness when looking back; there is richness in time. Then you need more vocabulary, various terms to discuss and describe it, and various ways of drawing it to see the nuances of this richness." In another group, a participant reflected: "Not every temporality is similar. Just because we call it temporality does not mean it falls under the same category… What becomes clear to me is that when we talk about time, we mean very many different things." In a third group, a participant said: "The conversation [mediated by visual mapping] helped me externalise my thoughts as I feel time is abstract and sometimes hard to put in words. It affected my thinking as it opened up to new perspectives while discussing."

FIGURE 12
Left to right and clockwise: depictions of river slopes combining different life durations and evidence from various geological eras, Black Elder tree and its two trunks, Creeping Buttercup flower, lichen and a sketch of a Lichen's timeline.

4.7 Considering multiple timespans simultaneously

Thinking through the perspectives of more-than-human actors allowed the participants to consider multiple timespans assigned to the actors. For example, one of the participants interacted with a Black Alder tree. When presenting her work to the group, she related to the presence of what she perceived as a 'young tree', assuming it is around 20 years old, and to an 'old tree', probably around 60. To evaluate their age, she compared the trees to ancient trees she knew. She then imagined a potential future where the trees' pollinating system would help recreate life on Earth (Figure 12). Thus, interacting with a single actor allowed the participant to consider several timespans, including the different durations in the past (age) and the far future.

Other participants who interacted with the river slopes mentioned that they are an accumulation of multiple timespans, including the 10,000-year-old landscape, the plants and the different organisms, all layered and entangled, as expressed in Figure 12. While interacting with a Lichen, another group of participants drew its timeline by placing rocks representing deep time on one side and trees, human objects, air pollution and death on the other (Figure 12). The 5,000-year-old Lichen was spreading between the two poles to mark the long span of its lifetime, as opposed to the relatively new phenomenon of air pollution driven by human actions that can lead to death. By creating this representation, participants contextualised the Lichens' temporal existence to deep time rather than human life. The coming together of different actors assigned to different timespans in the visual mapping made participants reflect on how they are entangled. A participant who interacted with a Creeping Buttercup flower related it to the Lichen: "If people do not move the flowers, they can last 10 years. When you said that a Lichen lives 5,000 years, it was shocking to me, such a different relation to time in the same space!" (Figure 12). Participants in another workshop suggested using the concept of 'shared time' to describe the coming together of different temporal scales.

5 Discussion

"These are the times we must think," writes Dona Haraway (2016), referring to our global urgency. This paper responds to Haraway's (2016) call by suggesting visual mapping can help understand more-than-human temporalities in participatory design by thinking through them. The term 'thinking through' indicates a reflective practice aiming for a thorough and careful understanding, future- and possibility-oriented. It differs from other ways of thinking, such as 'thinking about', which indicates a distance or a gap between the thinker and the subject of her thought, or 'thinking with', which could refer to an instrumental approach where the thinker uses one idea to develop another. Unlike other forms of thinking, it emphasizes engaging with directionality, materiality and pace.

5.1 Directionality

The word 'through' proposes moving in the space "from one end or side of something to the other" (Cambridge Dictionary, 2024). As such, 'thinking through' suggests a journey, a process of navigation, where the thinker moves around and sees things from different points of view. The idea of a crossing path resonates with the work of Hayes et al. (2021), who described the multiple temporalities in participatory design through the metaphor of co-responding lines and Edwards and Pettersen (2023, p. 9), who underlined the need for envisioning different durations in urban design processes, which they refer to as "visions of different lengths." Unlike the linear perception implicit in these metaphors, in our work, the path of thinking does not take the form of a paved highway but a branching of multiple side roads of emerging curiosities, ideas and questions about time. In Tsing's (2015) terminology, this is a knotting together of different stories rather than a single one, creating 'interwoven rhythms'. Our view of these journeys is of an accumulated experience, a kaleidoscope. In our experiments, participants could see time and temporality in their multifaceted dimensions. They navigated between more-than-human time as it is observed by humans and imagined the temporal experience of more-than-humans. They thought about time through various shapes; they managed to look deep into the past and far into the future; they explored different scales and unfolded the thickness of what time is and could be in the present. Some participants related to the more-than-human actors they interacted with as voyagers. Several participants related to the interconnectedness of temporalities, and some associated them with musical compositions creating "polyrhythmic patterns." These rich journeys allow participants to look into different cases, develop multi-levelled interactions, bring ideas together, question meanings, form questions, increase sensitivity, suggest new vocabulary, and embroider stories. It allowed them to reveal time multiplicity realizing that "when we talk about time, we mean many different things." From this angle, our work contributes to developing the temporal discourse in participatory design (Saad-Sulonen et al., 2018; Rapp, 2022; Søndergaard et al., 2023) and emerging more-than-human approaches in participatory design (Akama et al., 2020; Smitheram and Joseph, 2020; Wakkary, 2021; Laurien et al., 2022; Romani et al., 2022), and their intersection as more-than-human temporalities (Mareggi, 2013) by suggesting how we can start accessing the idea of more-than-human time with its nuances and richness. It is a methodological suggestion of "appreciating polyphony" and "listening both to the separate melody lines and their coming together in unexpected moments of harmony or dissonance. In just this way, to appreciate the assemblage, one must attend to its separate ways of being at the same time as watching how they come together in sporadic but consequential co-ordinations" (Tsing, 2015, p. 158). The methodology we describe in this paper helps participants to think through different aspects of time and to flesh out times' multiplicity. The rich temporal vocabulary we gathered here can assist designers in choosing an angle to explore more-than-human time. This work is a concrete proposal for addressing complexity in design projects by considering multiple stakeholders beyond humans.

5.2 Materiality

The word 'through' associated with the thinking process suggests a traverse motion, where ideas move and develop in a space where materiality serves as a medium. Similar to the Lily's body growing through the water while consuming its material qualities, thinking occurs through the physical encounter with the materiality of the environment: the water, the soil, the grass and the wind, as well as the materiality of objects used in the visual mapping activity such as paper, markers, organic materials and wooden bricks. When participants think 'through time' rather than 'about time', time itself becomes materialized as "the mind converts into physical dimensions" (Fisher, 2023, p. 124). This was evident when participants described time as 'dense', 'thick' and 'abstract', and in materiality-based ideas like "accumulated time" and "extracting from time." "It matters what thoughts think thoughts," writes Haraway (2016, p. 35), acknowledging ideas do not appear from an abstract transcendental source but evolve from a specific substrate, allowing them to grow as such. In our experiments, this substrate was made out of tangible and materialized interactions, developing the interpretation of what more-than-human temporalities could be. The methodology we describe in this paper can support designers in making time tangible, thus allowing them to approach this transparent and illusive concept and consider it in the design process. By approaching 'visual mapping' as thinking through the making process, we expanded Latour (1986) notion of the map as a communication device to carry a dual character. In our work, the materiality is connected with a situated, temporal and process-oriented approach, where the visual map becomes a boundary object (Harvey, 2024), a medium through which the participants can think. Like the old Chinese person who drew a map in the sand, our visual maps are not meant to last or function outside the encounter; therefore, they allow a fluid and momentary materiality. However, when we ask participants to visualize their individual experiences or impressions with the rest of the group and document the situated and temporary artefacts to share with a wider audience, the visual mapping becomes a communication device. Thus, another contribution of this paper is consolidating the term 'participatory visual mapping' (Buur et al., 2013; Gaudion et al., 2015; Vrancken, 2018), suggesting that when the terms 'participatory' and 'visual mapping' are combined, they give rise to a double mode of practice, which functions as a device to facilitate an embodied and complex thinking process and as an output. In the context of more-than-human temporality, it facilitates the understanding of time due to otherness and relationships (Latour, 1997) and serves as an output to represent and share this thinking with others.

5.3 Pace

'Thinking through' conveys a deliberately slower and detail-oriented way of thinking. Farías (2017, p. 39) wrote: "What quickness does is invoke a certain type of knowledge, one assumed to be straightforward, based on best practices and on mastering whatever needs to be done." Visual mapping allowed new knowledge to emerge by creating an 'attention attunement' (Hayes et al., 2021) through observing, sketching, listening, and commenting on each other's work. This particular element is expressed in the notion of 'workshop time' as a multilayered interaction of different temporal dimensions. Pschetz and Bastian (2018) recognized that dominant narratives of time have limited design possibilities because they simplify temporality into dichotomies, such as fast and slow. Indeed, 'workshop time' is often perceived as a solid term equal to its duration. This paper unfolds workshop time into multiple temporalities, including workshop duration, the online dimension and the participants' pace. Leveraging these categories can help designers supplement the limited workshop duration with technological dimension and apply a different pace. Visual mapping created the opportunity to slow down and counter the fast-paced work that often characterizes design.

6 Limitation and future research

This research intends to observe and analyze the impact of visual mapping as a methodological approach to thinking through temporality. Evaluating the effectiveness of the proposed methodology is difficult due to several reasons. First, temporality is abstract and non-tangible in nature and, therefore, difficult to grasp and describe in objective terms. So is the act of thinking, which is mostly an internal process. The evidence of the thinking process is, to a great extent, the discussion among the workshop participants and the visual output they create. However, we recognize that the quality of the discussion and the depth of the results are not only a consequence of the methodology itself but also depend on other aspects, such as the facilitation process and the participants' skills, visual literacy and previous knowledge. Therefore, more systematic research is needed to investigate the interplay of all these aspects.

Based on our experience in the workshops described in this paper, we envision several possible directions for future research. The first relates to broadening participation. The participants in this research came from Europe and were educated to a university degree. We believe exploring the topic with more participants from other cultural backgrounds and life stories will be valuable. As humans, we tend to project our perception and situated knowledge on more-than-humans; therefore, it may be the case that interaction with people from other backgrounds will result differently. Another direction for further research will be the aspect of materiality and how it informs our idea of time. In our program, participants developed their thoughts through more than human temporalities using different materials to create visualizations. Our impression was that the specific material quality affected the ideas that emerged. For example, materials of a certain nature, like markers, nudged participants to think about time in a linear way, while materials like wooden balls led them to think about time as movement. Future research could examine the impact of materiality on our understanding of time. A third direction of future research should integrate these results into a design process that includes complex environmental challenges in projects of multiple stakeholders to address the premise of this work, which is to understand more-than-human perspectives through a temporal lens better.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

HZ: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. LS: Conceptualization, Supervision, Writing – review & editing. AG: Supervision, Writing – review & editing. NM: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Understanding animal-oriented social media collaboration in Australia's 2019–20 bushfire crisis

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In the past decade, social media has served as a vehicle for sharing information and coordinating actions during sudden crises. However, much of the research has focused on local communities directly affected by crisis and the human recipients of aid. This paper explores a case where handicraft makers across the globe collaborated on social media—namely Facebook—to help Australian wildlife during the 2019–20 bushfire crisis. Based on 12 semi-structured interviews, we report how animal-centered visual content spread through a broader hybrid media system, arousing emotions that played a crucial role in increasing awareness of the crisis and catalyzing action. The findings highlight how participants actively sought possibilities for utilizing their knowledge and expertise within the project and experienced receiving immaterial rewards and benefits as compensation for their efforts. The findings also show how participants had various roles in the collaborative initiative—alternating between online and offline environments. However, the ongoing crisis coupled with the related pressure and stress, the rapidly increasing number of helpers, communication ambiguities, and technological challenges, led to chaos, heightened emotions, and fueled dissension within the group. These factors posed challenges to collaboration, further highlighting the negative and toxic communication cultures of social media. This paper enriches our understanding of how social media can enable, but also challenge, bottom-up community-driven, animal-oriented solidarity actions and long-distance crisis collaboration.

KEYWORDS

animals, collaboration, collaborative media, craftivism, social media, societal crises, solidarity, volunteering

1 Introduction

Due to the accelerating environmental crisis, weather extremes, such as heatwaves, droughts, bushfires, and floods, have become increasingly common. This has been demonstrated in Australia, where weather extremes have emphasized how human suffering cannot be seen in isolation from the suffering of non-human others. During the 2019/20 Black Summer Bushfires – the catastrophic bushfire season in scale and impact – an ongoing drought and record-breaking heat resulted in bushfires that burnt millions of hectares of land and killed billions of animals (WWF Australia, n. d.). In addition, numerous species, including endemic koalas and kangaroos, became injured, orphaned, and homeless (The University of Sydney, 2020; WWF Australia, 2023).

As one of the bushfire rescue initiatives, the Australia-based Animal Rescue Craft Guild put on its Facebook group a call for volunteers to make shelters and other items to aid animals. The group expanded rapidly and globally as the call brought together volunteer crafters who knitted, crocheted, and sewed mittens for koalas' burned paws and pouches for orphaned marsupials, among others (Animal Rescue Craft Guild, 2020; Reuters, 2020; The Guardian, 2020). The call for volunteers resulted in multiple sub-groups as people organized at national and local levels in their own Facebook groups. One of these sub-groups was established by one individual in Finland, on the opposite side of the Earth, named Suomen käsityöläiset Australian eläinten avuksi [tranl.: Finnish crafters to help Australian animals]. The group expanded rapidly and aimed to share instructions and tips for how to help Australian wildlife by making handicrafts and to coordinate a joint donation from Finland to Australia. As a result of the joint effort, a total of 110 kg, including 1,600 individual handicraft items, was shipped to Australia, which is a significant amount considering the relatively small Finnish population (Iltalehti, 2020; Suomen käsityöläiset Australian eläinten avuksi, 2020).

The action described above is a part of the development where people's environmental crisis awareness and engagement are constantly increasing due to the prominent role of social media (Filho et al., 2018; Mavrodieva et al., 2019; Östman, 2014). The prominent role of social media in increasing environmental crisis awareness and engagement is reflected by various scholarly interests in interdisciplinary academic fields. Social media's diffuse, diverse and even conflicting information (Skoric et al., 2016), enables public discussion (Fernandez et al., 2016; Gil de Zúñiga et al., 2012), facilitates environmentally conscious behavior by information acquisition and attitude formation (Anderson, 2017; Melville, 2010; Oakley and Salam, 2014; Williams et al., 2015), and mobilizes individuals around their personal lifestyles and values to engage with environmental activism and participation (Bennett and Segerberg, 2012; Karhu et al., 2019; Zhang and Skoric, 2018), to name a few. The volume of aid to Australian wildlife—from Finland as just one of many countries—illustrates how Australia was inundated with crafts aiming to help the animals suffering from the ecological crisis. This crafting phenomenon demonstrates how social media and the social networks relying on it make it possible to turn environmental crisis awareness into response action where people can contribute collaboratively.

The present case study explores social media-based environmental crisis collaboration through interviews with Finnish crafters who contributed their skills to help the Australian animals. It is not new that people help those in need through social media. However, typically, the recipient of help (often monetary) is a human being. In this case, collaboration takes place outside official infrastructures and organizational coordination attempts to offer non-monetary help to animals far abroad. Whereas related work has focused mainly on crises occurring in people's immediate surroundings, we aim to provide a rich empirical understanding of social media-based collaboration cultures in a long-distance crisis context where the crisis does not immediately affect the participants themselves.

In this study, we analyze interviews of 12 voluntary helpers to ask: 1) What drove the collaborative actions, i.e., what made people knit, crochet, and sew huge quantities of shelters and other items to aid Australian wildlife? 2) What forms of effort were identified? 3) How was social media—and the Facebook group—perceived as a platform for collaboration? Understanding these drivers and sociotechnical conditions makes it possible to nourish social media projects and platforms that increase bottom-up communities' capacity to collaborate in societal crises.

2 Related work

2.1 Animal-oriented solidarity

Our study is strongly related to "solidarity with animals," i.e., a feeling about being connected with other animals and a greater desire to help animals as well as to engage in collective actions on their behalf (Amiot et al., 2020). Researchers have emphasized a need to expand the lens of solidarity from domesticated to wild animals in an aim to reflect our multi-species communities (Cojocaru and Cochrane, 2023). Overall, people's capacity to empathize is important in concern and care that people have for the conservation of wildlife and nature (Myers et al., 2009; Taylor and Signal, 2005). In our study, the volunteer crafters knitted, crocheted, and sewed mittens for koalas' burned paws and pouches for orphaned marsupials, among others to provide protection and shelter (Animal Rescue Craft Guild, 2020; Reuters, 2020; The Guardian, 2020). Due to the quickly scaling efforts, local communities in Australia become overwhelmed with donated goods (BBC, 2020). On the other hand, one might ask if the crafted items really help animals or not (e.g., Time, 2015). Although the necessity and concrete benefit from the crafted items can be disputed, the phenomenon shows that people have a large-scale desire to help animals in distress.

Visual communication can trigger a strong emotional response (Casas and Webb Williams, 2018; Jenni, 2005; Kharroub and Bas, 2015; Whitley et al., 2021) and it has been recognized that visuals play a significant role in viewer's awareness and mobilization in animal advocacy issues (Cherry, 2016). On the other hand, prior research indicates that there is a great variation in people's attitudes toward animals, which depends, both animal and individual human attributes as well as cultural factors (Serpell, 2004). According to the research evidence, people show more concern for animals they perceive aesthetically appealing or "cute" (Gunnthorsdottir, 2001; Prato-Previde et al., 2022; Stokes, 2007). That is related to the concept of "charismatic megafauna"—i.e., particularly appealing animals—that are utilized in media for directing public attention toward conservation and preservation of the natural environment (Barney et al., 2005). In their research, Albert et al. (2018) ranked a list of the most charismatic animals and emphasize how most of the ranked species are large exotic, terrestrial mammals.

Research literature also emphasizes how humans prefer and show more concern for "human-like" animals (Batt, 2009; Herzog and Burghardt, 1988; Serpell, 2004). That is linked to people's tendency to project human thoughts, feelings, motivations, and beliefs to nonhuman animals—i.e., anthropomorphism (Serpell, 2003). Prior research suggests anthropomorphism increases prosocial behaviors toward animals (Butterfield et al., 2012; Williams et al., 2021) and is a key factor in stimulating a wildlife value shift in which wildlife are seen as part of one's social community (Manfredo et al., 2020). Further elaborated, Tam (2019) concluded that people who anthropomorphize nature are more likely to feel guilty for environmental degradation and in turn to take more steps toward environmental action.

To understand what drives citizens' crisis- related (animal-oriented) solidarity activities on social media, it is useful to look at the concept of 'post-humanitarian solidarity', coined by Chouliaraki (2013). Post-humanitarian solidarity describes how contemporary solidarity has moved from "'common humanity' towards a morality of 'the self' as the main motivation for action" (Chouliaraki, 2018). Therefore, post-humanitarian solidarity emphasizes solidarity as a pursuit of personal interests, self-fulfillment, and minor gratifications in a spirit of what's-in-it-for-me ethics (Chouliaraki, 2013). All these perspectives may have an explanatory potential for what drives people to use social media collaboratively in crises in an aim to help animals, but the information is fragmented and based on different contexts.

2.2 Social media use in crises

Today's crisis events emphasize the hybrid nature of media. In the hybrid media system (Chadwick, 2013), meanings are formed through the endless circulation of texts, visuals, and meanings in closely interwoven practices of professional, journalistic, and social media (Sumiala et al., 2018). In other words, social media is part of a broader hybrid media environment. Since the second half of the 21st century, a rapidly growing research field represented by scholars from different disciplines with different theoretical and methodological approaches has drawn attention to the role of social media in crises (Reuter and Kaufhold, 2017). The research cases are especially related to natural disasters (Liu et al., 2008; Starbird and Palen, 2011; Yates and Paquette, 2011), terrorist attacks (Palen and Liu, 2007; Perng et al., 2013; Wiegand and Middleton, 2016) as well as political uprisings (Starbird and Palen, 2012; Wulf et al., 2013). However, most studies have focused on local communities directly affected by these crisis events. Less is known about the use of social media in crises that are physically distant to the participants.

Altogether, it is evident that social media has broadened citizen participation in crises and made it more visible (Palen and Liu, 2007). When paying attention to communication among citizens as a social media usage pattern in crises (Reuter and Kaufhold, 2017), research interests in how social media enhances crisis awareness and how people make sense of the crisis events within an online network get particularly emphasized. It becomes evident that during crises, people turn to social media to look and share information (Hughes and Palen, 2009; Palen and Liu, 2007; Starbird and Palen, 2011; Takahashi et al., 2015; Yates and Paquette, 2011) that spreads through online social networks rapidly and dynamically (Albris, 2018) broadening its reach. In this informational sphere, social media also serves as a platform for collective emotion formation (Valaskivi et al., 2019). Overall, social media has been researched as a means to organize different types of individual and collective actions (Enjolras et al., 2013; Lim, 2012; Tufekci and Wilson, 2012), and this organizational capacity of social media seems to play a significant role in the creation of new movement forms (Bennett and Segerberg, 2012; Segerberg and Bennett, 2011; Theocharis, 2013). These movement endeavors can be scaled up (Mundt et al., 2018) as social media enables communication not only within the affected areas but also with the rest of the world (Takahashi et al., 2015; Valaskivi et al., 2019) by bridging the local and the global (Enjolras et al., 2013). All this is closely linked to how people can coordinate and organize their crisis response efforts (Albris, 2018; Sarcevic et al., 2012; Starbird and Palen, 2011; Takahashi et al., 2015), and how the ones in need of help can be connected to those offering it (Albris, 2018) through social media.

When paying attention to syntheses about the use of social media in crises—it is central how collaboration is mentioned as one aspect among the lists introducing how social media are used during these events (e.g., Alexander, 2014; Bukar et al., 2022; Spence et al., 2015). Nevertheless, when the research focuses on citizens' collaborative activities during crises, these activities are often lower-threshold micro-tasks, such as crisis mapping (*cf.* Liu, 2014). Also, most of the research focusing on the use of social media in crises concentrates on Twitter (Reuter and Kaufhold, 2017)—a microblogging service that serves the immediate needs for information (Valaskivi et al., 2019) and thus again emphasizes the above-highlighted interests that are related to making sense of the crisis events. However, little is still known about crisis collaboration, which requires more extensive efforts from its participants.

2.3 Spontaneous solidarity and craftivism on social media

The efforts that enhance mutual support and help, particularly during crisis events, can be understood in terms of 'media solidarities'. According to Nikunen (2019), media solidarities refer to how media expresses and enhances solidarity through various representations and engagements. The activities include, e.g., creating, "liking" or sharing content about social issues, signing online petitions, and donating to a cause (Gil de Zúñiga et al., 2013; Miller, 2015; Vicente and Novo, 2014; Warren et al., 2014). Though the described types of contributions have been referred to with terms such as "micro-activism," "slacktivism" (Dennis, 2019), or post-humanitarian solidarity (Chouliaraki, 2018), small gestures get multiplied when done by substantial amounts of people and create an environment that can inspire people to mobilize in larger and more coordinated ways (Miller, 2015). The mobilization is related to how digital volunteers form 'emergent groups' to support crisis response (Cobb et al., 2014; Palen and Liu, 2007; Reuter and Kaufhold, 2017; Starbird and Palen, 2011, 2013). Following the logic of "connective action" (Bennett and Segerberg, 2012), these groups are self-organizing, quickly scaling, and highly flexible bottom-up movements. However, the criticisms verbalized in terms such as slacktivism are well-aligned with the above-described notions about how low-threshold micro-tasks get emphasized in crisis collaboration—and apparently in solidarity actions as well.

On the other hand, people actually do things together in terms of solidarity by making use of social media in different ways (Nikunen, 2019). For instance, there are social media groups organized around craftivism (Black, 2017; Clarke, 2016; Nikunen, 2019)—a practice that draws on new social movements and social media and focuses on the use of crafts for activism (Nikunen, 2019). In contrast with today's digitally native social movements that are "initiated, organized, and coordinated online without any physical presence or pre-existing offline campaign" (Li et al., 2021), craftivism is participation that is "mobilized and enhanced through media but extends beyond media." Social media has expanded craftivism, and there are various social media sites where craftivists plan and organize their projects. Craftivism

highlights the importance of makings and entails many different versions, from demonstrations to art exhibitions and aid work (Nikunen, 2019).

Combined, these research contributions form a background for understanding the phenomena related to our case study in which we explore how handicraft makers united by Facebook collaborated to help Australian wildlife during the Black Summer Bushfires. Although crisis-related social media movements have been actively studied, prior literature includes few empirical cases that combine the use of social media to show animal-oriented solidarity in a remote crisis, particularly looking into the motivations of collaboration, the forms of collaboration in practice, and perceptions of technological affordances for collaboration.

3 Methods

3.1 Data collection

The data collection began by becoming familiar with the 'Finnish crafters to help Australian animals' Facebook group in Spring 2020. The first author did not participate in the community but acted as an outside observer (Rafaeli et al., 2004) for identifying active participants and potential interviewees (Hine, 2015, pp. 79) among the group. Identified potential interviewees were then contacted initially through private messages for requesting an interview. In addition, an open call for interviews was published in the group. After the initial contacts, the interview arrangements and practices were agreed upon with the interviewee by phone or email according to the interviewee's preference.

The research has followed the research ethics procedures of University of Lapland, Finland. With communication technology mediated interviews, conducted remotely with participants, the informed consent for participation is retrieved orally, before starting the actual research study interview part. The study participants do not represent a vulnerable participant group and the interview does not address any sensitive personal information. This procedure is valid accordingly to the local legislation and the university research policies.

For eliciting participants' individual reflections on social media-based environmental crisis collaboration, altogether 12 interviews were arranged in March–April 2020: ten via online meeting platforms or phone and two via email. Interviewees included the founder of the group, other group admins as well as 'ordinary' participants. The semi-structured interview was selected as an interview method as it allows openness and flexibility by proceeding loosely and focusing on pre-planned themes (Bryman, 2012; Hirsjärvi and Hurme, 2022) but leaving room for participant-driven discussion as well as participants' own interpretations and meaning-making. The interviews were conducted in Finnish and covered four main themes: the role of news and social media in increasing crisis awareness and engagement, drivers for collaboration, forms of efforts, and the role of Facebook as a platform for collaboration. Though two of the interviews were conducted through email, they allowed the above-mentioned 'participant-driven discussion' in a written format. The 10 interviews conducted via online meeting platforms or phone were audio recorded with the interviewees' consent. The duration of those interviews was, on average, 35 min, varying according to the interviewees' openness and number of examples discussed.

3.2 Data analysis

The interviews were transcribed from the recordings, and the data was anonymized at this stage. The dataset was subjected to thematic analysis (Burnard, 1991) for identifying, classifying, and analyzing different themes that arose from participants' individual reflections. One researcher identified the initial codes and emerging themes and established a thematic codebook by searching, reviewing, refining, and naming the themes. The codebook was reviewed by two other researchers. After that, the researcher who established the codebook conducted the first analysis round. To enhance the reliability of the analysis, a second researcher independently went through the interview data and coded it according to the codebook. A third researcher decided on the codes in cases where the two researchers had given different codes to a data item.

4 Findings

In this section, we report key findings from the interviews. After presenting the drivers for collaboration, we present how collaboration was organized and maintained, and how participants perceived the technological framework for their collaborative efforts. The participant quotes have been translated from Finnish to English when writing the paper.

4.1 Drivers for collaboration

4.1.1 Visual communication of suffering animals as catalysts for the sense of crisis

The case study highlights how news stories and social media content – as a broader hybrid media environment – generated both crisis awareness and the sense of crisis as well as promoted a chance to take part in the craft guild initiative.

> "It was hard not to notice that news coverage […] Those koalas and others were on the forefront of the [social media] feed" (P4).

> "Someone linked the Facebook group to me, then another one, and then a third one… And it had been talked about in a newspaper. It kind of jumped to my eyes from many different media" (P2).

Following the bushfire crisis through hybrid media raised emotions that drove collaboration in the craft guild. Participants described the horror caused by the situation.

> "People were sincerely horrified by the situation, and I think this sincere horror caused the positive movement. People felt a sting in their hearts and wanted to do concrete things in an aim to help" (P6).

Visual communication of Australian animals in distress played a crucial role in arousing the described emotions. The participants of the group shared continuously plenty of images related to suffering animals by themselves too. The images were shared from news stories as well as other social media sources, including the main

Australia-based Animal Rescue Craft Guild group. There were also photos that presented the handcrafted aid "in action": kangaroos in pouches and koalas with mittens among others. According to participants, photos and videos presenting suffering animals got them to act.

> "There were posts and news from every channel about how koalas had burnt themselves and how kangaroo puppies were without a mother. I got hopeless and needed to do something" (P12).

Overall, this is attached to an animal-related emotional bonding which was a central driver in getting participants to collaborate as a part of the craft guild. Participants emphasized their close relationship with nature and animals. Also, Australian animals' uniqueness and certain kind of cuteness played a role in catalyzing participants' actions.

> "I was aware of how unique flora and fauna is in there, and how great loss it would be to the Earth if they were permanently destroyed" (P11).

> "Even though Australia is very far away, everyone knows what a koala looks like. And everyone knows what a kangaroo looks like" (P2).

> "It was also affected by such cuteness. I believe that if they had asked to craft something for crocodiles in there, people would not have been so much activated" (P9).

Participants also emphasized how animals are innocent beings that must be helped in human-made crises.

> "For some reason, it is easier for people to start helping animals than other humans. […] Compared to elderly people, for example, many may think that they have their relatives and money, let them buy their blankets" (P2).

> "Animals and children are those who are completely innocent in this world. They should be helped. […] Grownup people here do what they do, and that has certain consequences. […] Yes, this Australian disaster is, in a way, human made. […] It was a matter of time before this bomb exploded" (P3).

4.1.2 A chance to deploy the right combination of interests and skills

A chance to deploy the right combination of interests and skills was a central driver for collaboration in the craft guild. As one of the participants summed up:

> "It is great in these projects that you can combine all the tools you have on the table" (P6).

At first, making handicrafts was a beloved hobby for many.

> "Sometimes, I cannot come up with what I could craft for myself when I have already done so many things" (P4).

In addition to crafting as a hobby, some participants had an education or profession in the field, willing to deploy their skills for the volunteer project.

> "I have a craft education as one profession, and I craft a lot anyway. So, it kind of clicked immediately that 'okay there, I am going participate in this'" (P9).

Therefore, participants felt there was a low threshold to participate in the project that matched their interests and skills.

> "For me, sewing is a bit like putting shoes on. It is not an effort of any kind" (P2).

Participants generally emphasized the significance of clear and easy instructions that lowered the threshold for participation. The instructions were visual and, in addition, plenty of photos of finished crafts were shared in the group.

> "It was easy to get involved because there were clear instructions on what kind of pouches the kangaroos should have. […] It made it very easy to get excited" (P5).

Though most participants had a background in handicrafts—a hobby or even a profession—some learned new crafting skills in the project that they perceived exciting.

> "Everyone who knows me said, okay–now you have even started knitting. I have been the worst in the world to make any crafts. But I got a new hobby, and I am excited about it" (P6).

Crafting skills were just some of the skills that participants got to utilize in the craft guild. Many had previous background and experience in, e.g., (animal) volunteering and that thus worked as a driver for collaboration.

> "I do a lot of charity work in any case. […] So the first thought that came to my mind was what kind of help Australia needs in this situation. What would be a concrete, useful way to help" (P6).

Specific skills were needed in the craft guild, and those participants whose skills matched the needs recognized themselves and offered to help. The group administrators asked whether there were participants able to, e.g., translate the instructions or craft sewed items.

> "There was a discussion among the administrators that the instructions should be translated. So, I wrote there [in the Facebook group] that if you needed a translator, I could translate too" (P4).

> "The administrators asked whether there was anyone who was able to sew because there were already loads of knitted and crocheted items. […] It was such an alarm to me" (P2).

Overall, participants experienced that collaborating in the craft guild was a concrete way to contribute with their interests

and skills and help Australia in the bushfire crisis. Participants also emphasized that they were willing to help in non-monetary ways.

> "Financially, I would not have an opportunity to help. For once, it was such 'yay', I can do something too" (P5).

4.1.3 Rewards and benefits

In the interviews, participants described versatile rewards and benefits they experienced receiving, and that therefore drove them to take part in the collaborative effort. At first, participating in the craft guild was a way to channel one's craft enthusiasm. Participants brought up how they craft a lot in any case for the joy of doing—whether the items were needed or not. Now handicrafts had recipients awaiting them.

> "It is good that the frenzy of doing can now be gutted into something necessary" (P2).

In addition, one of these rewards and benefits was a chance to utilize material stocks that participants had, according to their own words, "cabinets in full."

> "I had extra fabric, which fits well with such a purpose. […] I like the idea that no stuff and no fabrics are wasted, but some purpose must be found for them. […] That was my motive" (P10).

Also, the rewards and benefits wrapped around various immaterial aspects: from getting a theme for a kid's birthday party to finding pedagogical synergies with work in early childhood education.

> "This year, we held birthdays on this theme [crafting aid items together with guests at kid's birthday party]. So, in a way, it also had such a selfish perspective that I got a solution to one of the birthday parties" (P2).

For some, the reward was simply to get to do things together.

> "Then I believe in the power of the community. And in doing something together. It is always really motivating" (P6).

4.2 Organizing and maintaining the collaboration

4.2.1 A need for administrators

Participants had various roles in the craft guild. In the first place, administrators were responsible for setting up the group. In addition, the group of administrators took care of practicalities, such as communicating up-to-date information to group members, coordinating domestic item shipments, and negotiating transportation sponsors to the end destination in Australia. As one of the administrators described in the interview:

> "I was mainly involved in the group's maintenance activities and provided technical support. I ensured that all the information needed was found in the group, it was easy to find and understand, and everything went smoothly online" (P11).

As a detail, being an administrator or conducting administrative activities was not self-evident, but there were also struggles regarding who had the right to do what in the group.

> "They started to solo—for instance, asking all kinds of sponsors and did not collaborate with us [named administrators]. We administrators had the big picture about what should be done and how" (P1).

4.2.2 A variety of different roles

Making handicrafts was at the core of participation for many. Participants crocheted, knitted, and sewed items for Australian animals:

> "I started knitting small animal bag covers. In particular, I crocheted bird nests" (P9).

In addition, participants took care of various support tasks. These included, e.g., coordinating material donations and item shipments, translating crafting instructions, and sharing information and news among the participants as well as in participants' networks outside the group.

> "People started sending me messages that they would like to bring used sheets and towels […] because there was a wish that recycled materials are used for crafting the items" (P3).
>
> "I collected the donations in our region and mailed them to the domestic collection point [hub]" (P9).
>
> "I translated a large part of those crafting instructions" (P4).
>
> "I was pretty active [in the Facebook group]. I shared much news in there" (P5).
>
> "It [information about the crafting event] was shared into different [Facebook] groups. […] I also shared information, for example, to *marthas* [a Finnish non-profit organization that engages in advocacy work] and seniors in the area" (P6).

Participants described how visual communication played a central role in documenting and sharing the activities.

> "In the group, there was a picture of a large pallet, which was full of cardboard boxes of the same size, tightly packed. It was probably 2.5 meters high. So, there were quite a lot of handicrafts from Finland overall" (P3).
>
> "I published a picture on my social media of the girls sewing the items. Many said that oh no, I would have liked to participate too. But it was already too late" (P2).

Some participants also arranged offline events for crafting the items together. Next, this form of participation will be looked at in more detail.

4.2.3 From online to offline participation

Making handicrafts is an offline activity by nature, and people arranged gatherings and events for crafting the items together. Interviewed participants' experiences describe the variety of these get-togethers, from meetings with friends to children's birthday parties and open events with a wide audience.

> "I organized an event here in my residential area with a local knitting cafe. People were allowed to attend—to come to the place to knit, exchange ideas, and bring their ready-made items within a certain time" (P6).

Experiences from offline events further illustrate the ability to participate in different roles.

> "There was so much that people could do. Some said that I cannot sew; I have never sewed. So, I said okay, but you can cut. There were some tasks for everyone" (P3).

The interviewed participants emphasized the significance of experiences from offline events. The significance arose from, e.g., community spirit. Participants also felt it was essential to increase awareness about the bushfires when meeting people face to face.

> "Many thanked us all for the warm-hearted discussion and such power of community. […] We all come from different paths in life. Nevertheless, it is not what matters. What matters is that we are in that situation and doing something for good together" (P6).

> "I also noticed that there are people who just do not know about things. Some were quite unaware about the bushfires" (P3).

4.3 Experiences from the technological framework of collaboration

4.3.1 Reach and rapid expansion of the group

Participants emphasized how Facebook was an incomparable channel to reach people. It is descriptive that the group was established on Facebook because it was the only platform that was familiar to the administrator who established the group.

> "I cannot use anything else. I am so foolish that I do not know any other [platforms] than Facebook" (P1).

In addition, participants brought up how craft-makers can be reached from Facebook as a particular platform.

> "It seems that a lot of middle-aged people have joined Facebook. Furthermore, those people also have more crafting skills […] Like-minded people then find each other" (P4).

On the other hand, news media reporting supported the reach of the Facebook group as news pieces about the craft guild were published. That highlights the hybrid nature of media. Many people joined the group due to the reach supported by these news pieces, as one of the administrators described in the interview:

> "At first, there were about a hundred people, but when there was a story in a tabloid, it kind of exploded, and there were quickly over 5,000 people" (P1).

4.3.2 Sharing and structuring up-to-date information

At first, crafting instructions were shared in the Facebook group. In addition, utilizing Facebook as a platform for collaboration offered the possibility to ask and give advice, serving as a site for peer support and an interactive and communal way of doing things.

> "Australia[n authorities] had come up with instructions on what to do. […] It felt straightforward. […] You can just print the patterns and instructions" (P3).

> "If someone asked that she does not get how this should be done […] there were people who immediately told how to do it" (P5).

In terms of sharing and structuring up-to-date information, the amount of volunteer crafters did not explode only in Finland but also globally. Due to that, the situation was in flux all the time in Australia. No one could have expected such an amount of donations, and volunteers in Australia had to sort the avalanche of crafts to give up-to-date information about the items that were still needed. The challenges caused by the enormous volume of aid affected the activities of the Finnish group.

> "I would have done more, but there were announcements that you must stop crafting; nothing can be done now because there were so many items already. […] The situation of whether to craft or not was constantly monitored" (P7).

Sharing up-to-date information describes how the Facebook groups enabled a multidirectional flux of information from the Australian parent organization to and within local craft guilds around the globe. Participants told how one of the benefits of Facebook was the ability to share real-time (*in-situ*) information.

> "I think this group did an excellent job of constantly informing people that 'do not do this, do this, now there is a need for this'" (P6).

> "There were also members from Australia, who sent photos and updates from the spot to see the situation in there. It somehow diminished the world and made it more relatable" (P4).

Visual communication played a key role in sharing and structuring up-to-date information. As mentioned above, the group shared, for instance, a lot of pictures of animals in distress as well as crafts and instructions for making the crafts. Moreover, visuality was present in the group's communication, for example, in the form of emojis.

> "And if there was terribly sad news, there were those teary-eyed signs" (P5).

4.3.3 Dissension and heated emotions

Due to the ongoing crisis, the situation and conditions were constantly changing in Australia. Simultaneously, the number of crafters sending aid increased exponentially and globally. Aid was delivered simultaneously from many continents and time zones. Though updates about the crafts needed were constantly published in the group, providing up-to-date information was challenging and confusion easily arose. At the same time, the acute crisis created pressure and stress—and made people long for quick action. Together, the circumstances created a challenging equation that caused dissension and heated emotions in the group.

> "Some are such that give everything to me immediately and does everything not progress in a second. What is now needed, and what is not needed, and am I doing it in vain? There was such a commotion. […] Many were upset that this was not going faster, and now there is a rush. There the forests burn, and we here do not even get the package sent" (P2).

Participants described how people in the group expected real-time communication and rapid response that, on their part, contributed to above-described dissension and heated emotions.

> "Some get angry when they do not get an answer. […] You join the group and do not get the answers you seek. So then comes the frustration that you are not being listened to, what is happening now, and this is a badly organized project" (P4).

Participants also described actual trolling and bullying that occurred in the group.

> "Then there was one, well, a troll. It was such terrible harassment and making personal remarks against me" (P1).

> "The administrators received harassing messages. It seems that even when we try to do something good, there are always side effects like this" (P4).

On the other hand, participants discussed that the described dissension and heated emotions reflected the overall Facebook communication cultures that they perceived as negative.

> "You cannot expect any great reception or constructive discussion on Facebook, which is not the forum for that. To put it ugly, it is more for those who want to bicker. Or otherwise, mix things up in some way" (P6).

Overall, the described aspects connect to participants' perceptions that Facebook is not a state-of-the-art platform for this kind of collaborative action.

4.3.4 Facebook is not designed for collaborative action

Overall, participants felt that Facebook is not designed for collaborative action demonstrated by the craft guild.

> "Although it is a good place to connect people, it seems that it is not designed for such collaborative activities. In fact, this action and this platform do not fit together" (P4).

At first, participants described how Facebook does not adapt to the needs of individual groups.

> "Facebook group page is designed for a general use. Harnessing it to a particular purpose is trickier. […] It lacks the flexibility that would have been needed" (P4).

Often, participants were looking for the latest information, and Facebook's algorithmic logic confused them.

> "That system has changed so much. The posts are not in a chronological order […] The challenges get even more emphasized when you should stay up to date. And Facebook messes that up" (P4).

There were also challenges in Facebook's communication practices as people constantly asked the same questions in new comment threads. The challenges got emphasized as the group rapidly expanded.

> "When people get excited, they ask all kinds of things. They did it by posting or commenting. Then there were loads of side chains that repeated the same things" (P9).

> "If you are an active Facebook user, you may read every comment and all the conversations. Surely it is quite confusing" (P2).

In addition, reasons for Facebook's impracticality as a collaboration platform were found in participants' skills in IT and social media.

> "For some reason, not all people could find or retrieve those files and attached publications" (P9).

> "However, I am already over 60, so for me, using Facebook and understanding where everything is located is not always so clear" (P7).

5 Discussion

We first highlight the trinity of drivers for collaboration, followed by a discussion on the division of labor in the interplay between global and local and between online and offline action. Finally, we discuss balancing between the reach of Facebook and its adaptability for crisis collaboration.

5.1 The trinity of drivers for collaboration: appealing to emotions, reason, and values

Concerning participants' motives, the chance to help the affected wildlife by crafting appealed to this unique interest group's emotions, reason, and values. Participants emphasized how they received visual news reports and social media content about suffering endemic Australian animals from multiple channels—highlighting the hybrid nature of media – and how that offered a relatable manifestation of the distant events. Reinforced by the algorithmic logic in recommendations on social media, the flood of alarming information on people's social media feeds inspired individuals to not only share information, opinions, and experiences but also to act. Participants'

vivid expressions of burning koalas and fleeing distressed kangaroos seem to be significantly related to suffering as a cause for emotion and action (Chouliaraki, 2010, 2018), and how imageries of pain and emotional language of emergency play a key role in that (Calhoun, 2010). Regarding emotional dimensions, it has been argued that circulating affects play a crucial role in gaining attention in hybrid media (Sumiala et al., 2018). Further elaborated, Papacharissi (2014) has focused on how the expression of sentiments mobilizes and connects crowds in the digital age – and coined the term affective publics to describe these practices. This is related to how solidarity becomes articulated through emotions that social media makes use of (Nikunen, 2019) and how social media can be a site for collective affect management in the immediate phase of a disaster (Valaskivi et al., 2019).

Historically, images of attractive and appealing animals are widely used, e.g., in NGOs' animal advocacy campaigns (Milton, 2011). Our findings illustrate how visual content of suffering yet attractive animals was central to arousing emotions such as anxiety, horror, and fear. According to widespread scholarly understanding, people find cute furry animals attractive and appealing, and therefore worth protecting and conserving (Colléony et al., 2017; Gunnthorsdottir, 2001; Milton, 2011). Still, as pointed out by Milton (2011), the appearance of animals (e.g., cuteness or ugliness) is related to how animals are made as objects of concern and protection following changing cultural priorities. In Milton's example, Australians and New Zealanders perceive possums differently though it is the same animal. That is interestingly interwoven with a question about whether people are more concerned about the environmental crisis if it threatens cute animals than unappealing ones (Milton, 2011). In our study, the participants experienced that it was important to help endemic Australian animals—without underrating their cuteness. As one of the participants pointed out, a certain kind of cuteness of Australian animals such as koalas played a role in driving the solidarity actions. She believed that people would not have been activated if crafts had been asked to do, for example, for crocodiles. In general, Finnish people are known for their close relationship with nature. According to a survey conducted in 2021, 90% of Finnish people consider nature important to themselves (The Finnish Innovation Fund Sitra, 2021). It is remarkable how, in our study, many participants argued to have a special bond with animals: for example, some had prior volunteer experience in animal rescue work.

Invoking reason was based largely on participants' experiences about matching skills and needs. They had relevant interests and skills – be it a hobby or profession among handicrafts, experience in volunteerism, or collaboration expertise such as translation skills. That is related to how social media provides an opportunity to become active in issues close to one's heart and use one's skills (Nikunen, 2019). What is also interesting here is how Finns are traditionally craftspeople. A hobby that is important to one was now even more important, and participants got to help with this 'superpower' they had. As suggested by Nikunen (2019), craftivism combines technological individualism with collaborative collectivity and emphasis on care, and by doing so, seems to respond to the current calls for solidarity. Joey poaches and koala mittens crafted by the participants may be understood in terms of optimistic emissaries of the solidarity of strangers (Malkki, 2015). What also supported the dimension of reason was a perception of an easy way to participate and offer concrete aid instead of donating money. Nevertheless, selfless activities were combined with self-interest when participants experienced getting rewards and benefits from the action. These were, for example, getting rid of accumulated material storage or simply getting praise from others. It describes how altruist pursuits were combined with egoist dimensions. Combined, these drivers for collaboration describe the ethos of post-humanist solidarity, which emphasized a morality of 'the self' as the primary motivation for humanitarian action (Chouliaraki, 2013).

It was noticeable that participants did connect the bushfires to broader global themes, such as the climate crisis, but this was not remarkably verbalized in the interviews. Instead, the animal emergency gave a concrete form of occurrence to an environmental crisis and invoked, e.g., participants' ecological values. As suggested by Tschakert (2022), more-than-human solidarity and multispecies justice are interesting approaches to encompass both the human and the natural world and the interconnections between them in the environmental crisis. One might think that people have more empathy for animals than they do for other people. For instance, the participants in our study emphasized how innocent animals suffered from the human-caused crisis. The empirical research by Cameron et al. (2022) shows that context plays a major role when people's willingness to choose empathy for animals versus humans is researched. According to their findings, people emphasize with animal suffering but disregard it when it conflicts human needs (Cameron et al., 2022). We may ask if people empathize with animals as long as it is not out of their interests. In other words, whether the suffering of animals leads to actions to prevent climate crisis and thus extreme weather events when people should compromise for their achieved advantages. Also, previous research has posed a question about whether these kinds of actions are only momentary experiences of solidarity (Nikunen, 2019) and pragmatic management of suffering or do they offer a basis and carry a vision for a meaningful social change (Chouliaraki, 2018). Nikunen has suggested that craftivism as a means of making things together may result in more lasting ties for political participation than social media activism often does (Nikunen, 2019). This is a question that would require long-term studies and remains therefore intriguing.

5.2 Dividing labor in the interplay between global and local and between online and offline action

Overall, the case demonstrates an inspiring project that successfully mobilized individuals. Participants' roles in the craft guild describe a division of labor in the collaborative action. Participants did not only knit, crochet, and sew items but also administered the Facebook group and took responsibility for various support tasks, such as coordinating material donations and item logistics, translating handicraft instructions, acquiring sponsors for transporting the items to Australia, sharing information including updates on the spot from Australia on Facebook, and arranging offline events for crafting together—to name a few. Visual communication was connected to each role in one way or another. The participants described how crafts and instructions for making them, as well as other group activities such as donated materials and organized offline events were documented in photos shared in the group. On the other hand, this division of labor illustrates how

collaborative media creates collaborative communities oriented towards shared goals and action. Various activities were built around the core activity that needed their authors. A suitable way of participation was found for everyone. Previous research has suggested that "slacktivist" cultures are "rife in the era of social networking […] and encourage people to click and contribute to online polls and issues, but that does not enable an engagement with real issues in the world of the here and now." (Thomas, 2014). In our case, people were empowered to do concrete things to help Australian wildlife. What was also interesting was how there were also participants who learned new skills to make handicrafts. This poses a question about how these phenomena inspire people to participate, even it requires extra effort.

On the other hand, the project emphasized 'the ease' of giving material aid. Although making handicrafts requires an effort, some participants brought up how rewarding it was to get rid of their material storage. The 'hubs' were drowned in old sheets and other material donations that people eagerly wanted to give away. This is related to (also criticized) forms of solidarity, where people are used to getting rid of, e.g., their old garments by donating them to countries "in need." Also, e.g., in the Ukraine war, it has been seen how people eagerly donate goods and act outside of official structures, e.g., giving rides to Ukrainians fleeing the war to other countries.

The research also illustrates the interplay of actions on global, national, local, and individual levels. The volunteers were organized on a national level, as illustrated by the case study on hand. In addition, national groups were further divided into local units where people, for example, gathered donations in the region and made handicrafts together in face-to-face events. At the heart of it all, individual efforts—be it making handicrafts or helping in the above-described support tasks—were combined to achieve a collective goal. This interplay demonstrates in a very concrete way how environmental crisis as a global phenomenon creates global movements that act locally. The relationship between collaborative media and offline action was also notable in the research case. This is aligned with the notions about how craftivism as participation that is mobilized and enhanced through media but extends beyond media—settling in the intersections of digital and material realms that are increasingly intertwined due to the ubiquitous media (Nikunen, 2019). The donated number of handicrafts illustrates how the online platform catalyzed offline action with a remarkable global volume. Making handicrafts is not only an offline activity by nature, but participants also organized offline events for crafting donated items together. That poses a question about the role of online spheres in these kinds of collaborative crisis action cases. In this research case, it was mainly building awareness, reaching people, sharing information, planning collaborative activities, and coordinating the joint effort.

5.3 Balancing between Facebook reach and its adaptability for crisis collaboration

The findings indicate how reaching and engaging people in a crisis initiative requires a use social media platform that people use anyway in their everyday lives. In our case study, Facebook was an incomparable way to reach people, and participants saw that it could reach the mass with which the right participants could be found and engaged. This is also the case considering the statistics. In 2020, Facebook was the most followed community service in Finland where 58% of the population used the service. In comparison, 39% of Finns used Instagram, 13% Twitter, and 6% TikTok (Tilastokeskus, 2020). Often, people belong to Facebook groups according to their hobbies and other interests. In this case, many participants were members of different kinds of nationally and globally organized craft groups where they learned they could help Australian animals by making crafts. This points out how these groups created around these preexisting hobbies and interests have a role in bringing about action. Facebook also serves as a means to reach older adults (Sinclair and Grieve, 2017), which also often includes the makers of handicrafts. Reaching people is also a question about the linkages between social media and a broader hybrid media environment as news stories generated both crisis awareness and the sense of crisis as well as promoted a chance to take part in the craft guild initiative.

The reach of Facebook is linked to sharing and obtaining information as a primary function of social media in crisis situations (Eismann et al., 2016). Our case study demonstrates a multidirectional flux of information from the Australian parent organization to and within local craft guilds around the globe. That enabled the above-discussed interplay between global and local levels and peer support among participants, e.g., asking and giving advice and dealing with the situation together. Overall, visual expressions played a key role in the group communication. For example, lots of pictures were shared of suffering animals, crafted items, as well as instructions for making the crafts. The communication of the participants in the group was otherwise visually emphasized. The participants referred, for example, to the use of emojis in the group communication.

However, participants experienced that it was problematic to successfully organize the information that was in constant flux during an ongoing crisis. Fast-paced communication led to challenges, that were especially emphasized in cross-continental cooperation where people were in different time zones. As a result, it took much work for participants to find the answers needed. They expected rapid responses to their questions, which was not always possible when sorting out information from a country on the other side of the world in a completely different time zone. At the same time, the acute crisis created pressure and stress. All in all, the rapidly growing group was in chaos at times. The described circumstances caused dissension and heated emotions in the group. In a bigger picture, that is related to the toxicity of social media (Almerekhi et al., 2019; Pascual-Ferrá et al., 2021) as a broader phenomenon, and the participants also discussed how these negative communication practices of social media were present in the project. Dealing with crisis contexts, it has been regarded that as crises progress over time, social media becomes increasingly a space for conflicts that may construct social distance (Valaskivi et al., 2019).

In sum, our case study highlights balancing between Facebook's reach and its adaptability for crisis collaboration. The findings illustrate the potential of utilizing and harnessing existing social media community services as platforms for collaboration during societal crises. In general, social media have been successfully used in crisis response due to their adaptability. This means that people adapt social media to fit their needs during a crisis (Yates and Paquette, 2011). Consequently, the rise of new media formats and practices may speed up during crises. For instance, the Fukushima nuclear disaster in 2011 was a breakthrough moment for Twitter in Japan as people actively sought new information channels (Valaskivi et al., 2019). However, our case study demonstrates how this type of collaborative action and Facebook as an existing social media

community service did not fit together. Our participants' experiences highlight how the action takes place according to terms and legalities not designed for the specific action in principle—and how the action is affected by the pre-existing social media communication practices and cultures that may be toxic. In contrast, craftivist projects are often operated on smaller self-organized platforms outside the main commercial social media (Nikunen, 2019). On the other hand, participants brought up how everyone involved did not have sufficient technological skills to use Facebook. That poses a question about whether the technological challenges were an issue with the platform itself or with the group moderators' and members' social media literacy. In the light of our research results, both factors played a role, and the question is interesting for further research. However, the results indicate that it might be challenging to introduce entirely new platforms for the needs of crisis-related collaborative projects. Overall, the research sheds light on collaboration as a social media affordance that refers to the possibilities of action that materialize in the interplay between the actor and technological boundaries (Faraj and Azad, 2013; Sumiala et al., 2018).

5.4 Limitations

We acknowledge the bias due to the participant sample and its geographic limitation, as the study was run in one European country. In addition, we acknowledge that our research is limited by the method, which relies on people's own expressions. However, we believe our research brings interesting viewpoints from people's subjective experiences. We provide an overview of the versatility of themes related to participants' experiences of the drivers for collaboration, organizing and maintaining collaboration, and technological framework for their collaborative efforts. In doing so, our research contributes to the research discussion on social media-enabled collaboration in (long-distance) crisis contexts.

6 Conclusion

In this paper, we have presented why and how craft-makers far abroad united and helped Australian wildlife in the 2019–20 bushfire crisis and how they perceived the technological framework of the collaboration. Based on 12 semi-structured interviews with Finnish helpers, the findings report the trinity of drivers for collaboration as the chance to help the affected wildlife by crafting appealed to this unique interest group's emotions, reason, and values. Visual news reports and social media content—i.e., hybrid media environment—presenting suffering yet attractive endemic Australian animals played a crucial role in arousing emotions—such as horror, anxiety, and fear—that catalyzed action. Overall, the participants experienced that visual expressions played a key role in group's communication. The crucial role of visual content emphasizes how representations are employed to support human collaborations that are catalyzed by non-human actors. In terms of reason, participants actively sought possibilities for utilizing their knowledge and expertise within the project. Further elaborated, selfless activities were combined with self-interest when participants experienced getting rewards and benefits as compensation for their efforts. The animal emergency gave a concrete form to the environmental crisis and invoked participants' ecological values, pointing out their willingness for more-than-human solidarity actions. Participants' roles in the craft guild describe a division of labor in the collaborative action, where activities in online and offline environments alternated. Facebook enabled an incomparable reach and lead to a rapid expansion of the group. On the other hand, the ongoing crisis with the related pressure and stress, rapidly increasing number of helpers, communication ambiguities, and experienced technological challenges caused chaos, heated emotions and fueled dissension in the group. This posed challenges to collaboration, further highlighting the negative and toxic communication cultures of social media. While the research illustrates the potential of utilizing and harnessing existing social media community services as platforms for collaboration during societal crises, it highlights how the action takes place according to terms and legalities not designed for the specific action in principle. It became evident from the study that toxic social media communication practices challenged collaboration and negatively affected the group's atmosphere. Overall, the paper enriches understanding of how social media enables, but also challenges bottom-up communities' animal-oriented solidarity actions and long-distance crisis collaboration.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

MK: Writing – original draft, Writing – review & editing. AR: Writing – original draft, Writing – review & editing. TO: Writing – original draft, Writing – review & editing. JH: Writing – original draft, Writing – review & editing.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The (im)possibility of communication with nonhuman beings: with digital screen printing of luminous bacteria

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In the current media environment, John Durham Peters emphasizes the importance of non-verbal communication and notes that underpinned by digital technology, "media" is returning to its original meaning as the milieu that surrounds living beings. To concretize and critically discuss this idea, this paper examines the artworks created by the authors, which incorporate microorganisms into digital technology. These works applied luminous bacteria as ink to digitally screen print text and images. The first work, *A Medium for Images or Luminous Bacteria (2022)*, prints Japanese text with luminous bacteria ink. The second work, '*イ* (I)' *(1926) by BioLuminescent Bacteria (2024)*, recreates the first image in the history of Japanese television, '*イ* (I)', with luminous bacteria. This paper compares and analyzes these practices in light of classical media theory, including the work of William Ivins Jr. and Marshall McLuhan. The paper introduces another work, *Grow.|Glow. (2023)*, to further expand the discussion to contemporary digital media. Finally, drawing on the recent arguments of Anna Tsing and Antonio Damasio, we elucidate the critical implications that the works of luminous bacteria bring to the current media environment.

KEYWORDS

milieu, luminous bacteria, digital screen printing, bio-media art, halftone, involvement, nonscalability

1 Introduction

In his book, *The Marvelous Clouds* (2015), media scholar John Durham Peters estimates the current media environment as follows: whereas traditional media understanding has developed based on one-to-one or one-to-many communication models, with the advancement of digital technology including the internet, the 21st-century media environment has become an encompassing network surrounding us. In this sense, "media" reverts to its original meaning as the milieu surrounding living organisms. From this perspective, he examines the communication of non-human animals, such as dolphins and whales, which use ultrasound, ultimately arguing the importance of non-verbal communication.

> "Currently nonverbal signifies the remainder that is left when you take away language from human communication, but it ignores the meaningfulness found in nonhuman nature. How odd to describe that part of communication that most ties us to nature as lacking! (p.380)."

Acknowledging the current situation where digital technology has become our surrounding milieu, it becomes increasingly important to focus on the nonverbal communication that is often overlooked due to the efficiency of these technologies that is particularly the case when considering communication with non-humans. In effect, Peters draws attention to the fact that "our bodies are embedded in climate history, fire regimes, the spin of the earth, north and south, and relations with plants, artifacts, and organisms of all kinds, especially each other" (p.380).

These ideas are intriguing as they open up the concept of communication, traditionally understood exclusively from a human perspective, to the relation with non-human realm. However, the last point, quoted from the concluding part of work of Peters (2015), sets the agencies of non-verbal communication so broadly, ranging from artifacts to other organisms, that it becomes difficult to pursue a specific discussion.

This paper aims to concretize and extend these ideas critically by examining our works that integrate a form of nonhuman life, bioluminescent bacteria, with screen printing realized by a recent digital technology. By comparing and analyzing the significance of non-verbal communication in these works against classical discourses in media studies, the paper seeks to reconsider these ideas. To this end, the following section will present the techniques common in the works *A Medium for Images or Luminous Bacteria* (2022) and '*イ(I)*' *(1926) by BioLuminescent Bacteria* (2024) (Figures 1, 2), comparing them with the arguments on print technology and television by scholars such as William Ivins Jr. and Marshall McLuhan. Finally, by examining another work, *Grow.|Glow.* (2023) with reference to the arguments of Anna Ting and Antonio Damasio, the paper will consider the (im)possibility of non-verbal communication with nonhumans and elucidate the critical significance of these findings for the current media environment.

2 Materials and methods

2.1 Bioluminescent bacterial ink

The works created by the authors all employ a unique print media that is made possible by culturing luminous bacteria and converting them into ink. The printing technique involves a culturing medium of the agar as the support, and digital screen printing, a form of computer-mediated reproduction technology. This method, a type of screen printing, uses a mesh stencil with cut-out text or shapes to apply ink, and today, computer-controlled printing based on binary images is possible.

However, unlike conventional ink, the bioluminescent bacterial ink remains alive on the agar medium, necessitating a constant supply or care of nutrients from the medium. Additionally, the figures created by the bacterial colonies in a mosaic pattern continue to change unpredictably after printing. Due to the faint light emitted by these bacteria, which inhabit ordinary marine environments, a completely dark room is required for exhibition, where viewers must wait for several minutes before they can see the work with the naked eye. Furthermore, these bacteria do not emit light as single organisms. This is because the emission of light is controlled by the detection of population density by the bacteria as a group. This is called Quorum Sensing and is realized by individual bacteria sending and receiving autoinducers to and from each other (Miller and Bassler, 2001). By this system, blue-green luminescence is initiated only when the bacterium is multiplied at a constant density. This suggests the presence of chemical-based communication among individual bacterial cells.

In addition, this phenomenon is not exclusive to luminous bacteria because some species are known to have symbiotic relationships with other marine organisms, such as squid and anglerfish, for the ecological interdependence (McFall-Ngai, 2014).

FIGURE 1
A Medium for Images or Luminous Bacteria (2022): overall, A4 size.

FIGURE 2
'イ(I)' (1926) by BioLuminescent Bacteria: overall, 180mm diameter glass dish on a stand.

These host organisms have specialized organs that provide nutrients to the luminous bacteria. In return, as the bacteria proliferate within these organs, they serve as light-emitting organs for the hosts, aiding in predation and mating. Despite the confirmation of such symbiotic relationships, the purpose behind the luminescence of the bacteria themselves remains unknown.

The authors cultured luminous bacteria in a liquid medium and absorbed them into gelatin to create ink. Specifically, the luminous bacteria were cultured for 24 h in Marine Broth 2216, a liquid medium designed for marine organisms, and then absorbed into 5% gelatin. When thickening agents like xanthan gum were used to create a paste, the luminous bacteria died. Therefore, the authors referred to previous examples of luminous bacteria in Japan and succeeded in creating bacterial ink using gelatin.

2.2 Digital screen printing

With regard to the silk screen printing used with this ink, this technique involves passing ink through a screen stencil to print images onto a substrate. Typically, the screen is a mesh fabric stencil coated with a UV-sensitive emulsion. The areas where ink is to pass through are blocked with a negative image during exposure. This allows for gradient representation through halftone and the resolution is determined by the number of mesh threads per inch. Historically, screen stencil printing has been used in various cultures for centuries, but an original technique of silk screen printing as mentioned above emerged almost simultaneously in the United States and Europe from the late 19th to the early 20th century (Lengwiler, 2013). Today, digital control allows screen stencils to be created by burning holes into the screen using heat, enabling its production directly from digital images without manual intervention.

Using this digital silk screen printing method, the authors created works by printing luminous bacteria onto agar media. The agar substrate was made by solidifying the same medium used for ink creation with 1.5% agar. Image data were created using Adobe Illustrator, and the screens were made using a Mi Screen A4 screen maker and 120 mesh screens. After tightly affixing the screens to the agar substrate, luminous bacteria were applied, and the screens were immediately removed, allowing for the printing of our original ink. In other words, these works can be realized as living prints created with nonhuman agencies.

The bioluminescent ink reaches its peak luminescence approximately 24 h after printing, necessitating careful timing in preparation relative to the exhibition's opening. Due to the faintness of the emitted light, a completely dark room is essential for the human audience to perceive it. This condition requires darkrooms for preparation and exhibition, such as the room for photo development, where the author and audience are completely blocked off from external light and concentrate on viewing the self-illuminating work. The works in a dark room for several days, and viewers must allow their eyes to adjust to the darkness for a few minutes after entering the space to perceive the images. Only after undergoing this process can the work be properly viewed, however, the initial figures of living prints transform gradually for the period of exhibition so that viewers can never see the identical image.

2.3 Discourses

In considering works that utilize such materials, we would like to confirm and review classical discourses related to visual communication at first because our works are based on traditional communication methods such as printing (on paper) and television, as detailed later. Here, we will examine the arguments of two scholars, William Ivins Jr. and Marshall McLuhan, who have analyzed these media, respectively, more than half century ago.

First, in his 1953 seminal work, William Ivins Jr. defined visual language as exactly repeatable pictorial statements, and explored how this concept has evolved primarily since the Renaissance (Ivins, 1953).

> "The printing of pictures, however, unlike the printing of words from movable types, brought a completely new thing into existence it made possible for the first time pictorial statements of a kind that could be exactly repeated, during the effective life of the printing surface. This exact repetition of pictorial statements has had incalculable effects upon knowledge and thought, upon science and technology, of every kind. It is hardly too much to say that since the invention of writing there has been no more important invention than that of the exactly repeatable pictorial statement" (pp. 2–3).

Ivins Jr. positioned "the exact reproduction of pictorial statements" as a historical invention, comparable to the invention of the letterpress, emphasizing its significant role in the development of modern science including engineering, archaeology, and ethnology (Ivins, 1953, pp. 2–3). From his perspective on the history of visual communication, the precise replication of images is fundamentally different from the printed text, which still has the auditory nature involving "the necessary arrangement of word symbols in a time order." Because through the introduction of printed images, even perceived through

the visual sense, "we see a picture first as a whole, and only after having seen it as a whole do we analyze it into its component parts. We can begin this analysis at any place in the picture and proceed in any direction, and the final result is the same in every case" (p. 75).

In other words, while textual media and their associated descriptions and interpretations follow a linear order, visual communication through images leads to disrupting this traditional linearity. Certainly, up until the 18th century following the invention of prints enabling the reproduction of images, interventions by draftsmen and engravers inevitably distorted the original drawings, necessitating specific pictorial techniques during plate production. Therefore, Ivins Jr. highlighted the revolutionary impact of the halftone technique, which emerged in the 19th century and enabled mass printing of photographs, emphasizing it as follows:

> "In the improved half-tone process, there was no preliminary syntactical analysis of the thing seen into lines and dots, and the ruled lines and dots of the process had fallen below the threshold of normal vision…At last men had discovered a way to make visual reports in printer's ink without syntax, and without the distorting analyses of form that syntax necessitated" (p. 128).

Viewed in this context, the transition from the dominantly linear nature of written language to visual communication via "exactly repeatable pictorial statements" could be seen as completed through the halftone technique and, consequently, the "cross-line screen." In contrast to the mass production of colored playing cards using stencils in medieval Europe, several technologies for stencils with parts connected by strings emerged from the end of the 19th century in America and Europe, as we mentioned above; from the patent obtained by Benjamin Walker in 1884 in the U.S. for attaching stencils to wire mesh, to the one of Jehan Raymond in France and England at 1906 and Samuel Simon in England at 1907 using silk gauze in stencils.

The simultaneous emergence of the technology for silk screen printing might be described as completing a historical transition from textual to visual communication. In any case, such technical frameworks have certainly integrated with digital technologies up to the present. In short, the lineage of visual communication emphasized by Ivins Jr., which replaced grid-like materials with lace, metal, and ultimately pixels, has been passed down to current communication tools dominated by computation and pixel-based digital displays.

Ivins' exploration of visual communication history may be perceived as somewhat biased because it centered around the reproduction of artworks. It was Marshall McLuhan who engaged in a broader cultural discourse on communication succeeding the former's arguments, but not limited to artistic ones. His 1964 groundbreaking work, *Understanding Media*, traces the historical evolution of media technologies and is famously known for its thesis that "the medium is the message," focusing more on the psychological and social effects of media formats rather than their content (McLuhan, 1964).

For example, using the analogy of electric light, he explained:

> "The electric light escapes attention as a communication medium just because it has no 'content'. And this makes it an invaluable instance of how people fail to study media at all. For it is not till the electric light is used to spell out some brand name that it is noticed as a medium. […] For electric light and power are separate from their uses, yet they eliminate time and space factors in human association exactly as do radio, telegraph, telephone, and TV, creating involvement in depth" (p. 9).

The characteristics of light discussed here will also influence our artworks. Before delving into that, it is essential to confirm McLuhan's distinctions between different levels of involvement or participation across various media, expressed through the famous terms "hot media" and "cool media." While hot media refers to high-definition media such as printed words or photographs, which are characterized by low viewer participation, cool media refers to relatively low-definition media where sensory or physical participation and involvement from the viewer are required. Among these, television is a low-definition image with scanning lines, compared to high-definition traditional visual media such as photography and cinema. In other words, it has become a privileged object of "cool media," due to its use of a "mosaic form" which was believed to enhance viewer participation compared to traditional visual media.

> "TV is, above all, an extension of the sense of touch, which involves maximal interplay of all the senses. […]Phonetic writing, alone, has the power of separating and fragmenting the senses and of sloughing off the semantic complexities. The TV image reverses this literate process of analytic fragmentation of sensory life (p.333)."

McLuhan, who posited that media technologies themselves determine the content of communication, viewed television as a technology enhancing tactile sensitivity, in other words, inducing sensory effects vastly different from visual extensions like photographs and text. Television, classified as a "cool" medium, was explained as an extension of tactility because it mobilized viewers' bodies and senses, while simultaneously integrating the sensory fragmentation and disintegration historically caused by traditional textual media. Thus, McLuhan's perspective, although slightly divergent in focus, shares commonalities with Ivins' discussion of reexamining the forms of media communication from the historical perspective of techno-civilization.

When juxtaposed with these classic theories of communication and media, how can we interpret our own works? Although the classic arguments by these two media theorists offer a stimulating perspective even today, it is also true that they retain a partially anthropocentric viewpoint. Whether drawing inspiration from their debates around print technology or television media, then, what kind of effects might arise when non-human agencies such as luminous bacteria are introduced into a human-centered communication system, which were absent in their discussions? In the following sections, we aim to investigate these effects based on the individual specificities of our artworks.

3 Results

3.1 *A Medium for Images or Luminous Bacteria* (2022)

Actually, the creation of images through luminous bacteria is not our novel endeavor. A pioneering example dates back to World War

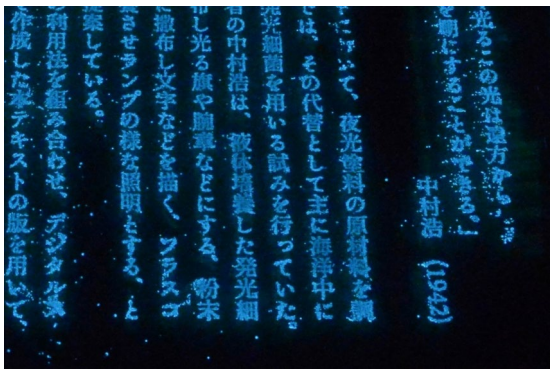

FIGURE 3
A Medium for Images or Luminous Bacteria: close-up.

II in Japan, where the potential use of luminous bacteria was explored (Harvey, 1952). Among the Japanese microbiologists, Hiroshi Nakamura investigated the use of these bacteria as a low-intensity lighting solution during nocturnal air raids, addressing the scarcity of domestically produced luminous paint due to material shortages. Because these bacteria were easily harvested from the nearby Pacific Ocean (Nakamura, 1942), he proposed creating emergency signs by applying them like ink or adhering them to powder to draw letters and symbols (Nakamura, 1940).

While the details of this historical background are discussed in a separate article (Saeki et al., in print), *A Medium for Images or Luminous Bacteria* critically reinterprets this wartime history by repurposing the bacteria as a medium for print. In fact, the Japanese text (re)printed in this artwork are cited form Nakamura's original research explaining the conception of this work with bioluminescent bacterial ink (Figure 3). The following is an excerpt from the introduction of the work.

> "The blue-white glow in the dimness is unseen from afar, yet it can unveil the whereabouts of objects" (Nakamura, 1942 trans by authors).

Thus, while Nakamura advocated for the utility of luminous bacteria, the shapes of the letters in this work are physically disrupted as the bacteria proliferate. In practice, the piece employs a method where one print is produced each day using the same screen, exhibited over 5 days. As a result, each print varies significantly, not only due to changes occurring every 24 h but also because of the correlation between individual differences of bacteria and external factors such as humidity and temperature.

Viewers must allow their eyes to adjust to the darkness before they can perceive the work, thus reading and learning about the wartime use of luminous bacteria only after spending a certain amount of time. Concurrently, the piece transforms the letters and figures constantly but imperceptibly: as the bacteria grow, the fixed typography and layout established by digital silk-screen printing gradually deteriorate. In this way, the work transitions from concrete text to abstract imagery through the growth of luminous bacteria. This transformation embodies the shift from a wartime application to an artistic one that illustrates a process where anthropocentric attempts to utilize biological organisms during wartime are deconstructed by the very microorganisms themselves.

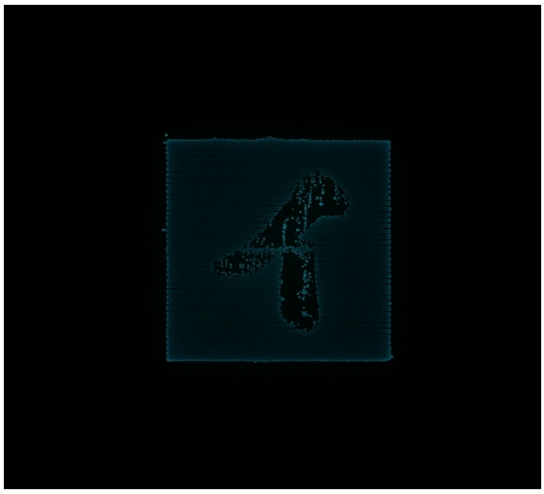

FIGURE 4
'イ(I)' (1926) by BioLuminescent Bacteria: after 40 h.

3.2 *'イ(I)' (1926)* by *BioLuminescent Bacteria* (2024)

The work *'イ(I)' (1926) by BioLuminescent Bacteria* connects the spontaneous luminescence of living print with the history of CRT (cathode-ray tube) technology developed for the television (Figure 4). Initially not necessarily conceived as a one-to-many communication technology, television was formed in the first half of the 20th century through intense development competition from the United States to Europe and Japan (Abramson, 1987). Kenjiro Takayanagi is one of the Japanese pioneers who enabled the transmission and reception of television images using a cathode ray tube (Suematsu, 2006). Takayanagi believed that mechanical receivers could not display high-definition images, so in 1926, he combined a Nipkow disk in the transmitter and a CRT display in the receiver to successfully transmit and receive images. At this time, the katakana character 'イ,' was chosen as the image to transmit, which is equivalent to the letter 'A' in the modern Japanese syllabary order (iroha order) commonly used at the time. Takayanagi allegedly transmitted and received the character 'イ' written with a brush and ink on mica using 40 scanning lines (Miura, 2006). In the 1920s, research using cathode ray tubes was also being conducted by Westinghouse's Zworykin and Philo Farnsworth in San Francisco, who attempted to apply them to imaging devices. However, only Frank Gray at Bell Telephone Laboratories and Takayanagi were researching their use in receivers.

In our artwork recreating this symbolic image with luminous bacteria. The 'イ' gradually appears, composed of 40 scanning lines as the bacteria proliferate. Over time, the character is distorted by the bacteria's life activities, eventually connecting the scanning lines and transforming from a mosaic form into a continuous large surface. This change progresses mainly due to the influence of external environmental factors as well as the previously discussed work. For the viewers a process known as dark adaptation (Kalloniatis and Luu, 2005). Dark adaptation involves the switching of photoreceptor cells on the retina, which not only enhances brightness perception but also alters color perception. Because the degree of dark adaptation varies among individuals, each viewer perceives differently the colors of 'イ'

composed by the bacteria, despite having the common feature with cathode-ray tubes that they emit light themselves.

3.3 Revisiting the classical media theory through the nonhuman

Given this specificity of our work as such, we would like to confirm again the discussion of Ivins Jr. which regarded the pictorial replication as an extraordinary step "[i]n the whole history of human communication." It is because this technology that did not necessarily require the human intervention of a draughtsman and engraver and "[m]an had at last achieved a way of making visual reports that had no interfering symbolic linear syntax of their own" (pp. 176–177) of the traditional textual information. While the automation of such operations might seem unremarkable from today's perspective, it is undeniable that this process has undergone further refinement, especially with the advent of computers after the publication of Ivins Jr.'s work, leading to advancements from contemporary text editing software to AI-driven automatic generation (Manovich, 2010).

In contrast to the technological advancements, *A Medium for Images or Luminous Bacteria* adopts the simple and mechanical aspects of printing technology akin to halftone in the form of a "digital screen." Simultaneously, it incorporates the nonhuman agency of luminescent microorganisms, allowing viewers to experience the disruption of the printed output. As the luminous bacteria activate and eventually perish, the printed text loses its legibility, and the human communicative tool of linguistic information becomes dysfunctional along with the enabling digital technology. Our work (re)introduces an agency different from both humans and machines into the process that operates "below the threshold of normal human vision," to paraphrase Ivins Jr.'s words, which halftone originally had achieved.

Consequently, the process of disassembling written language in this work can be viewed as an attempt to reorient historically text information predominantly optimized for human communication through a form of non-human communication from a historical and critical perspective. Furthermore, the decomposition of the content drawn from wartime text and contexts makes it possible to reflect the purpose of military technology, an excessive manifestation of human technological advancements, with the aid of non-human agency. In this sense, the work can be situated as a critical endeavor aimed at challenging anthropocentric views of technology.

Similarly, let us proceed to examine another work in light of McLuhan's theories on television. In addition to his anthropocentric perspective on media and body, McLuhan's assertion that the low resolution of the television, which was rapidly proliferating during his lifetime, leads to prompts the "complex sensory involvement" among its viewers might seem incongruent with the current media environment, where LCD/LED monitors are ubiquitous in competing to achieve extremely high resolution and control below the threshold of human vision (ex. Retina Display). Nonetheless, much like his prophetic concept of the "global village," so-called attention economy, which prioritizes captivating human senses through countless network-connected monitor displays, could be considered to enhance "complex sensory involvement" actually even more than television once did.

'イ' *(1926) by BioLuminescent Bacteria* was conceived as a critical response to this contemporary media environment. Takayanagi's choice of the character 'イ,' the first character in the traditional Japanese Iroha order, likely stemmed from an ambition, whether conscious or unconscious, to position himself at the forefront of the burgeoning global competition in media technology development. Moreover, in line with McLuhan's theories, Takayanagi's endeavor can be seen as an attempt to overlay the hot medium of print extending the sense of sight through phonetic characters onto the cool medium of television, which significantly alters sensory modes. In contrast, '*イ*' *(1926) by BioLuminescent Bacteria* reassembles the symbolic character image with luminous bacteria, which self-illuminate similarly to a television CRT. As these microorganisms gradually deconstruct the character-image, the piece not only introduces non-human agency into the media history transition from print to television, but also invokes the ongoing interplay between technological advancement and biological processes.

Furthermore, it should be noted again that the bioluminescent patterns appear in different colors depending on each viewer's level of dark adaptation. This feature embodies the human sensory response to low-resolution images described by McLuhan as "tactile extension." Audiences are prompted to mobilize sensory participation and involvement beyond vision as they attempt to discern faintly emerging images amidst the visual deprivation of darkness. However, recalling critiques of McLuhan's media theory as sometimes leaning towards technological determinism, in this case, such effects derive not from the technical characteristics of CRT but rather from the properties of nonhuman microorganisms that glow only when gathered in darkness. As a result, while starting from the same 'イ' as a reference point, these features can be understood as highlighting a critical and alternative lineage to the current media environment, which subjects our attention towards singular content of information through television media, computers, and the internet.

4 Discussion

4.1 *Grow.|Glow.* (2023)

The discussions by Ivins and McLuhan examined the changes media technologies bring about on a perceptual level, preceding meaning or message, from a historical perspective of civilization. Drawing inspiration from these discussions while incorporating the agency of microorganisms, how can be explained our works' critical significance not only in relation to traditional media such as print and television but also in the context of contemporary digital technology? To further explore this point, we would like to introduce one final piece (Figure 5).

Grow.|Glow. (2023) is an artwork that overlays luminous bacteria on the grid structures similar to circuits and pixel images, which are fundamental to contemporary digital technology (Figure 6). A large medium, 1-m^2, is laid flat in a darkroom, initially printed with luminous bacteria in a grid pattern. From above, a device similar to an intravenous drip system continuously supplies culture medium throughout a 1-week exhibition. Where the grid patterns of luminous bacteria are shaped and highlighted, as nourished by the culture medium, they grow and spread unexpectedly, then eventually transform into abstract patterns. In fact, the printed grid begins to expand into circular shapes as the culture

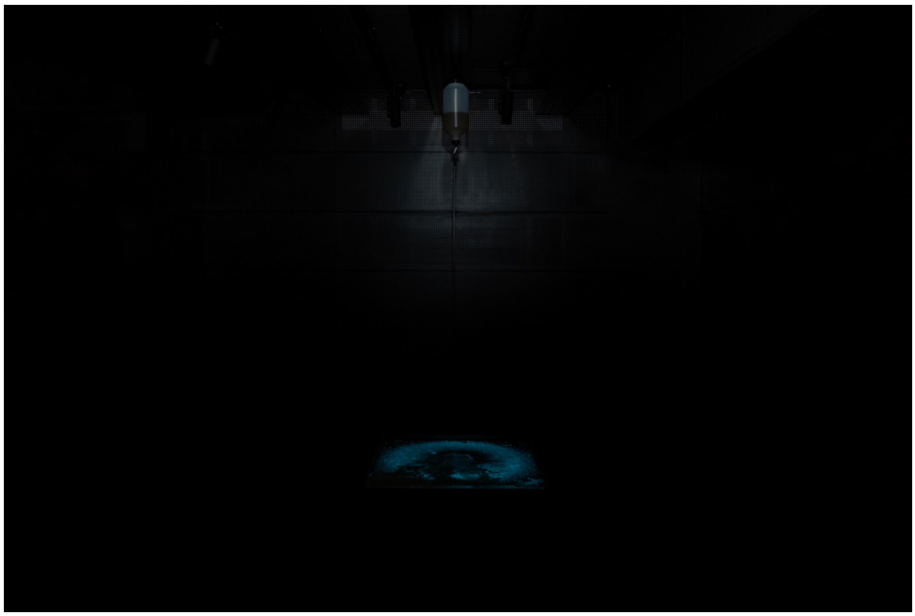

FIGURE 5
Grow.|Glow. (2023): overall, 1 m square medium set up horizontally, with culture medium supplied from the ceiling.

FIGURE 6
The first day: the luminous bacteria printed in a grid pattern.

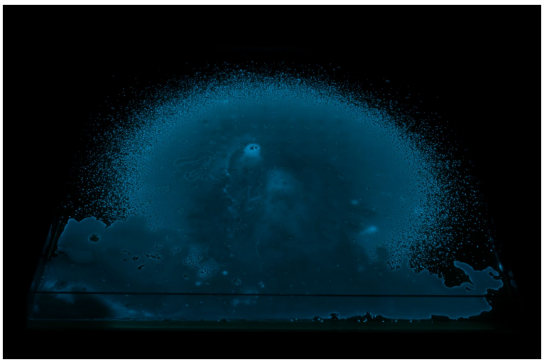

FIGURE 7
The third day: transforming into a large continuous circle shape and after-the-fact emergence of glowing particles.

medium spreads by the second day and, the original grid structure is entirely collapsed into a large continuous surface by the third day. Thereafter, the luminous bacteria extend beyond the boundaries of the initial patterns, proliferating into the surrounding area. Concurrently, countless glowing particles emerge sporadically and subsequently, and the grid occasionally happen to reappear with unpredictable transformations (Figures 7, 8).

These phenomena suggest that the luminous bacteria induced changes of their medium through their proliferation. The proliferation of bacteria and the decrease of ingredients cause an imbalance in their population within the medium, and that led to a decrease in the pH making it no longer a viable environment for survival. This environmental change prompted the bacteria to proliferate toward the outer regions where nutrients were still available, resulting in the observation of glowing along the periphery and in scattered locations. However simultaneously, due to the continuous supply of culture medium from above, the medium conditions eventually can be considered to revert to a more favorable state, allowing the surviving bacteria in the central region to resume growth, causing the grid pattern to reappear.

Thus, the emerging images bring about not only long-term changes of shapes over several days but also minute variations of perceptual experience for audiences situated in the dark environment. In the case of *Grow.|Glow.*, viewers sit in chairs installed for observation and, over several minutes to hours, gradually adjust to the darkness to stare at the artwork. During this time, frequent reports noted a faint wriggle and vibrate of bluish-white light within the viewers' field of vision. While the exact cause remains uncertain, it is unlikely that individual movements of each organism were perceptible, given the size of the luminous bacteria. Instead, this

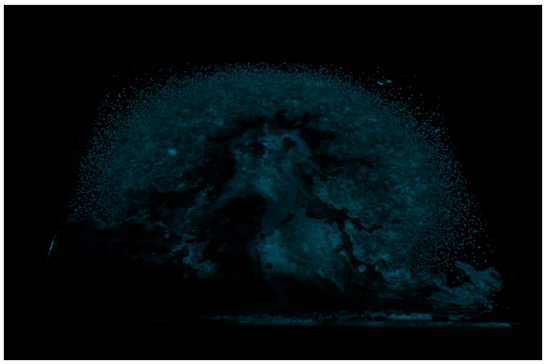

FIGURE 8
The seventh day: reappearance of the grid.

phenomenon is thought to be rooted in the physiological characteristics of human vision. In the darkness, viewers are unable to perceive peripheral visual information, thus they cannot correct saccade movements of their eye in response to luminous bacterial images covering a specific field of view. Consequently, viewers perceive a subtle trembling of their eyeballs in the image they are observing.

4.2 Revisiting the digital media environment through the nonhuman

Such features suggest a tendency completely opposite to modern visual media, which strive to stabilize content by excessively enhancing brightness and resolution. It also evokes John Durham Peters' observation, as quoted at the beginning, which argues the significance of reconsidering nonverbal communication in environments that encompass not only humans but also non-human organisms. However, while he carefully avoids detailed references within that context, it is a fact that interpreting animal behaviors, including dolphins or whales, as communication models often unavoidably falls into the form of anthropomorphism. On the contrary, it is hard to imagine anthropomorphism on luminous bacteria featured in our work, nor does this work attempt to consider the behaviors of micro-organisms as a metaphor for human beings. A vastly different scale of agency from humans suggests a sensory function that illuminates media as an environment and foregrounds nonverbal communication through the bodily and perceptual levels.

Of course, it is also true that current digital technologies are transforming media into environments rather than specific devices, such as the Internet, GPS, sensing technologies, and others. Even when focusing on imaging technologies, for instance, projection mapping creates expansive spectacles surrounding numerous audiences by adapting images onto arbitrary large surfaces like buildings. Furthermore, XR technologies merge real and virtual spaces, attempting to extend immediately individuals' visual fields through displays. While these technologies indeed illustrate how digital technology can transform the surrounding environment into media, they achieve this by overlaying a grid structure optimized for digital control onto physical space. Thus, no matter how much the real world is augmented, digital images fundamentally cannot escape the pixel grid structure.

Anthropologist Anna Tsing critically examines these tendencies of technology and points to behind it the relentless drive toward expansion as a characteristic of capitalism (Tsing, 2012):

> "The digital image is made bigger or smaller by resizing the pixels. Of course, pixels must therefore remain uniform, separate, and autonomous; they cannot bleed into each other or transform each other. Artists complain about pixelation, which fragments our vision of the world. Most of us do not care. But what made this technology so easy to imagine, I would argue, is the pixelated quality of the expansion-oriented world, which is something we ought to care about."

Here, scalability embodied by pixels refers to the ability to change the scale of an image without altering its content. However, as a consequence, enabling the enlargement of an image necessitates reducing it to uniform and homogeneous units (pixels), which risks expelling the diversity that each image or object inherently possesses. Tsing thus points out that these distinctive features of pixels underscore a fundamental principle common to and underlying capitalist societies, "the expansion-oriented world." She argues for the necessity to reconsider this background, urging a critical examination of the expansion-oriented world and its implications.

These critiques of anthropologists are relevant to our arguments which attempt to foreground the materiality of the communication including their scalability. Therefore, to contemplate nonhuman communication, it is essential to focus on the scale as a material foundation preceding its semantic contents and meanings, and the sensory effects that arise from it.

If we return to *Grow.|Glow.*, the luminous bacteria printed in grids via digital silk-screen are mutually influenced with the surrounding environment composed of agar, gradually deconstructing its structure. As previously mentioned, these bacteria luminesce collectively through quorum sensing, but their growth cycles transform their environment into one that makes individual survival challenging and prompts the group to move continuously. This phenomenon causes the transformations of the figure, observed in not only *Grow.|Glow* but also other pieces mentioned above. And it can indeed be understood as a manifestation that concretely embodies a nonscalable relationship between individual humans and a collective of microorganisms. Throughout these works, while the visual appearance may resemble conventional media technologies, the luminescence serves not as a message directed from microorganisms to humans, but rather arises solely from activities essential for the survival and growth of the microorganism. Expanding on McLuhan's insights regarding electric light, the light emitted by luminous bacteria should similarly be understood not merely as a superficial message but as an "involvement in depth," reflecting their intrinsic biological processes.

4.3 Further remarks on the nonhuman communications

Observing bioluminescent microorganisms glowing collectively in the darkness is perhaps one of the most primitive forms of non-verbal communication occurred in the medium as environment. To summarize the three pieces so far, they not only engage in discourse on human communication through the media theory but also trace its history of material basis. Indeed, *A Medium for Images or Luminous Bacteria* referenced print media, a communication tool relied upon by humanity

for centuries, '*イ (I)*' *(1926) by BioLuminescent Bacteria* symbolized the iconic screen of television as a mass medium, and *Grow.*|*Glow.* recreated images composed of units akin to pixels with luminous microorganisms. These attempts do not aim to attribute authorship to microorganisms. Rather, with the intervention of non-human agencies, these artworks provoke diverse perceptual responses in viewers, such as dark adaptation and saccadic perception, ultimately leading to the disintegration of their intended messages and contents.

In this way, through works constituted with microorganisms, this paper has pointed to the significance of the bodily and sensory levels that precede the meaning and content of communication, but of course some questions remain. For instance, the discussion thus far has been limited to the unique case of luminous bacteria among microorganisms that significantly differ in scale from humans. In addition, further examination is required to explore the relationship between the bodily and sensory exchanges these works illuminate and the conventional communication of meaning and intention assumed in ordinary higher organisms. As a threshold for the last point, the neurologist Antonio Damasio's point may be helpful.

In his recent book, *The Strange Order of Things*, Damasio has expanded the concept of life processes starting from unicellular organisms, like bacteria, to the consciousness, minds, and culture found in multicellular organisms, including human beings (Damasio, 2022). He locates the concept of homeostasis, a system for regulating the internal milieu of any organism, as its pivotal starting point and describes in the following way.

> "The sort of automated homeostasis that we find in bacteria, simple animals, and plants precedes the development of minds later to be imbued with feelings and consciousness. Such developments gave minds the possibility of deliberate interference with preset homeostatic mechanisms and even later allowed creative and intelligent invention to expand homeostasis into the sociocultural domain" (p.48).

While Damasio emphasizes the concept of homeostasis as the basis of the evolution of the mind in this way, he also continues and points out that "sensing and responding abilities" such as quorum sensing are essential and precede to "automated homeostasis" and the development of minds and consciousness. While we could not estimate and verify the accuracy and the implication of this innovative idea in the evolutionary theory, it would be possible to organize and distinguish the hierarchical levels of the communication between human and nonhuman beings.

At first, communication could be understood as the transmission of meanings or intentions among socio-cultural formations including (non-)humans through technologies such as printing, television, and digital devices. Second, the sensing and responding abilities for surviving or non-verbal communications are situated mainly in the medium as the environment prior to the communication understood in the above sense. And at last, we could add another dimension to these levels, which are beyond Damasio's argument, and not sure if we can call it "communication." Humans exchange and entangle with bacteria residing in their intestines and on their skin in everyday life, and engaging in their relationship is influence and essential for each other's biological activities. This relationship could be described as a form of biochemical level that precedes the communication based on symbols and scales.

Finally, we would like to remark on an interesting feature commonly observed in our works. Upon illuminating the darkened exhibition space where the works were displayed, it was astonishing to find substantial growth of brown and black molds on the bacterial culture medium. The origin of such molds could be contaminants introduced during production, brought in by visitors to the venue, or possibly propagated through the air during the exhibition period. Regardless of the cause, the fact that molds were thriving on the bacterial medium implies that units and hierarchies, such as individuals and collectives, cannot always be fixed, and that the circuits of communication between them are open to unexpected entanglement. What our works attempts to show above all is the critical significance of sharpening the bodily senses that can respond to such possibilities of communications.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding author.

Author contributions

TS: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. NM: Supervision, Writing – review & editing, Conceptualization, Funding acquisition. KJ: Funding acquisition, Supervision, Writing – review & editing, Project administration.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Post-humanist artistic research by production of performance and Techno-Lab workshops in Sapmi

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We are living in times of data-driven selves and data-defined artistic personas, an age in which the action of border-crossing has become a normative within an artistic work and an artist's life. We might cross the physical borders or the borders of our normatives. Each case of border-crossing awakens our awareness. The question of how an artwork is made is now as sharp as ever before. Contemporary technologies involving AI are opening a wide spectrum of possibilities for enhancing creativity and sustainability within the creation of performance artworks, which is traditionally seen as an individual process of a human creator. The main research question within this study is as follows: How can performance and workshop creation through collaboration between humans and AI and humans and technology be understood as post-humanist artistic research? The sub-question is: How is such a creation process different from artistic creation using traditional tools associated with artistic work? These questions are answered by investigating a case of Techno-Lab in Sapmi and a performance artwork creation process through the method of post-humanist artistic research. The key findings outline the main differences of post-humanist vs. anthropocentric artistic research and art production. The findings can be used to change the current normatives and enhance the radical transcorporeality through interconnections between humans and non-humans—in particular, technology and AI. The findings are relevant to art education and artistic practice representatives.

KEYWORDS

transcorporeality, creativity, performance art, workshops, AI, technology, Sapmi

1 Introduction

Artistic production involving technology has begun to enter the dimension of post-humanist discussion (Braidotti, 2013). Likewise, within artistic research extending the normatives of performance production in a collaboration between the artist-researcher and AI, the methodology becomes a post-humanist (Ulmer, 2017) artistic research methodology. Artistic production thus enters a completely different flow of creativity than the process by which the artist uses traditional tools to create an artwork. When an artist works with AI while creating the script and scenography for the performance, AI becomes a non-human collaborator rather than a tool (for example, a brush while one paints). However, the author of the artwork remains the artist, not the AI. This brings up the primary research question (How can a performance created through a collaboration between humans and AI be understood as post-humanist artistic research?) and the sub-question (How is such a creation process different from artistic creation using traditional tools associated with artistic work?).

This article aims to define the key points of how the process of artistic creation with AI is different from artistic creation using traditional tools associated with artistic work. Definitions will be given specifically for the work toward performance production. The objectives of the present work are as follows: to define post-humanist artistic research involving AI, to analyze the case of performance production through the perspective of post-humanist artistic research, and to define the main points on how such artistic research is different from anthropocentric artistic research.

This article suggests a new understanding of the artistic processes, by which technology and human activities are not contrasted as the master and the tools for the master's actions; instead, they are collaborators, imparting input to each other such that the artistic creation takes the shape of the creative loop (Griniuk and Mosich, 2022) from human to technology and from technology to human.

2 Post-humanism, AI, and performance are all interconnected

Although the rapidly changing technological possibilities outline the new procedures for artistic production, it seems that the methodologies of artistic research are a step behind the actual processes in art, particularly performance production. This statement is based on the research of scholars like Donnarumma (2019) and PhD Cand Ilja Mirsky.[1] These two authors, in my interpretation, base their mission on the post-humanism in the description by Braidotti (2013). Although the number of examples could be widely extended, it has become more usual now than, for example, in the last decade to involve AI in creative processes, and there is little understanding of precisely how this impacts the holistic methodology of such artistic research (and artistic production). So, the post-humanist take on artistic production can be defined from Braidotti (2013)'s perspective as something that *"indicates and actualizes the relational powers of a subject which is no longer cast in a dualistic frame, but bears the privileged bond with multiple others and merges with one's technologically mediated planetary environment"* (p. 92). This statement is connected to her discussion on *"becoming a machine"* (Braidotti, 2013), which, in my opinion, stands most radically aside from the anthropocentric way of thinking. "Becoming a machine" would question the authorship of collaborative work by humans and AI to a large extent and would explain how this collaboration is different from other creative processes involving an artist and a traditional tool for creation. Generative artificial intelligence (AI) builds around algorithms (such as ChatGPT) that can be applied to generate, for example, a new text, based on provided input.

As this paper focuses specifically on performance, we stress the importance of understanding performance on a wide scale. Performance can be analyzed in a variety of ways. Further, anything can be analyzed as a performance. Some of the most common ways to analyse performance are based on Goffman (1990)'s theories of performance, originally from 1959, which later became the background for Schechner (1977)'s method of understanding performance. These theories have impacted the understanding of performance by contemporary performance researchers, which could be exemplified by Philip Auslander in Cecchi (2021), explaining the foundations of his understanding of performance. Both Goffman's and Schechner's theories provide an overview of how performance functions in the world and how it is performed and interpreted by audiences. When one thinks about performance, the first thing that comes to mind is often the theatrical performance of actors on a stage. However, in the most basic sense, the term *performance* can be used to describe any instance in which a person or group performs a certain action or behavior. This is the way we suggest a performance should be seen to unfold the contemporary discussions about this media in ever-changing societal contexts.

As the main focus of this paper is AI, we will explain exactly how AI is involved in our work. AI, in this paper, is used in a general colloquial sense and refers to current technologies, mostly based on machine learning and neural networks, which are available for a general audience to interact with. More specifically, GPT-3, accessed through the AIDungeon service, was collaborated with, as well as the free image generating services hotpot.ai and huggingface.co. I intend for this paper, through the connection of three main themes of post-humanism, performance, and AI, to fill the gap within methodology studies by addressing the necessity to reconsider methodologies along with the changing relationship between the entities of performance production.

3 Post-humanist artistic research methodology for performance

Artistic research suggests a processual take on artistic production, by which the produced artwork assumes a format of investigation (Jones, 2006). Here, artwork can be interpreted as a case, though the term *case* comes from the social sciences. In this article, the investigated performance is addressed interchangeably as a performance artwork and as a case. Artistic research seeks to unfold possibilities for innovation within the artistic field (Busch, 2009). In this way, I suggest that reframing the perspective of artistic research and artistic production from an anthropocentric to a post-humanist one is in line with radical innovation (Trott, 2017). This provides new horizons and challenges in defining the new role of the human artist in transcorporeal collaboration (Griniuk, 2021), how to define authorship, and how such a new take on the process of art can impact the skillset training for artists within art academies and universities. Uniting the definition of *artistic research* with the theoretical definition of *posthumanism* by Braidotti (2013) and expanding it such that post-humanism is seen as a methodology (Ulmer, 2017), I suggest that the current study is developed through the methodology of post-humanist artistic research. Post-humanist

1 Being a young scholar, Ilja Mirsky, whom Griniuk had the pleasure of meeting in August 2021, actively works toward erasing the barrier between performance and technology – for example, during his workshop in Finland. Available at: https://opinto-opas.uniarts.fi/en/course/T-XD119/13210.

theory refers to a philosophical and critical framework that challenges traditional human-centered (anthropocentric) views of knowledge, and creativity (Alneyadi et al., 2023). In the context of education, post-humanist theory would suggest that intelligent applications (such as Alef, Connect, and Boclips) are not just tools for improving student performance but active participants in the learning process (Alneyadi et al., 2023), where Tashtoush et al. (2023) extends the discussion about the positive impact of Information and Communication Technologies (ICT) on the learning process. Post-humanism would frame these smart applications as co-creators of knowledge, enabling students to interact with scientific ideas in ways that extend beyond human capabilities alone (Alneyadi et al., 2023). Augmented Reality (AR) is as well defined as an active agent in reshaping learning and human interaction with knowledge (Hidayat and Wardat, 2023).

The artistic data were collected throughout 3 months of project planning and 2 months of its implementation. The hermeneutic approach to qualitative data analysis was employed as outlined by Thomas (2006). Thomas argues that traditional qualitative research methods such as grounded theory, phenomenology, discourse analysis, and narrative analysis may not always be suitable for all types of qualitative data. Consequently, he introduces *general inductive analysis*, a method that aligns with hermeneutic philosophy and is particularly effective for analyzing artistic data. General inductive analysis involves the systematic analysis of qualitative data based on specific research objectives, allowing insights to emerge directly from the raw data without being constrained by rigid methodological frameworks. This approach was applied to interpret the findings from the raw data gathered during the research.

The analysis was conducted within the hermeneutic framework, adhering to the guidelines provided by Gadamer (2004) and Thomas (2006). The data were analyzed by identifying key themes from the visual and aesthetic elements of the principal investigator's (PI's) performance production, as well as from notes taken throughout the process. These keywords were linked to the creation and presentation of the artworks and their symbolic meanings, including the scenography. The post-humanist themes are evident in the keywords, reflecting the collaborative nature of the creative process between human and non-human agents.

FIGURE 1
The silkscreen process. Photo by T. B. Mosich.

4 Unfolding the process behind Techno-Lab in Sapmi, Sami center for contemporary art in Karasjok

This section seeks to delve into the convergence of traditional Sami art, the surrounding natural environment, and state-of-the-art technology. It does so by initiating an innovation project, Techno-Lab Karasjok, situated at the Sami Center for Contemporary Art. The primary goals of the workshops are to establish Techno-Lab as a pioneering laboratory in Karasjok for techno-art exploration and to involve the local community, Sami artists, and curators in this creative process.

The case outlines the specific techniques and tools to be employed in the workshops, along with details regarding the timeframe and location. Drawing insights from the workshop data, the study aims to elucidate the interplay between human, nature, creativity, and technology in Sapmi. Furthermore, it endeavors to showcase how technology can enhance traditional creative processes. The research aspires to make a meaningful contribution to the realms of Sami art, technology, and creativity by innovatively incorporating technology into traditional Sami art practices while fostering a connection with nature and unfolds the core of the post-humanist vs. anthropocentric artistic research and art production. Techno-lab suggests a non-traditional take on artistic creation in the context of Sami creativity. Anyway it connects to the statement of the Sami artists, such as Per Isak Juuso, who already connects traditional duodji technique with the use of plastic and other non-traditional materials in the context of the introduction of his work as diadda-duodji.

5 Unfolding the process behind the performance "Interspecies talk in the shade of the manor"

For this case, the process of production is used in connection to the project "Interspecies talk in the shade of the manor," realized for the Hollufgård Sculpture Park in Odense in Denmark. The project evolved from the connection between the post-humanist, technological (AI in particular) take on production and the local narrative about the former wine cellar construction on the territory of the park to the left of the manor of Hollufgård.

The connective points between these two angles of the thematic approach, all of which are within the philosophical framework of post-humanism, were as follows. The wine cellar was, according to the local narrative, used for different purposes: the storage of food and non-food, along with other objects and items. The bats most likely are a species that has always been around, or, as it is now, inhabit the spaces inside the construction. So, the interconnected stories within the narrative were the wine cellar, the bats, the technology, and the shoes. The shoes came into the narrative mostly due to the time of performance production. Since

FIGURE 2
From the live performance by the PI. Photo by Mikkel Kaldal.

the war in Ukraine started, the PI has worked volunteer jobs sorting clothes and shoes in Denmark to be sent to Ukraine. The shoes that were not part of a pair were taken by the PI, and she created a costume out of them. Parallel with this, the shoes came in as a multilayered metaphor for the narrative.

A self-containing performance was developed as well as a one-time performance performed by the PI during the opening event of the artwork. In the self-containing performance, the people can experience the performance without the artist present by walking to the spots and scanning the QR codes (Figure 1). In this way, the audience members themselves take on the role of performer to whatever degree they wish.

Three silkscreen flags printed on thick fabrics with water-resistant silkscreen colors for textile were placed at the three locations. The images contain AI-generated images (Figures 2–4) themed around the narratives about the body of a bat. The images were the basis for drawings made by the PI and printed by the silkscreen technique (Figure 5) in the size of approximately 2.5 m × 1.8 m. A QR code (Figure 1) incorporated into the installation leads to the soundtrack.

FIGURE 3
One of the screen-printed flags after installation. Photo by T. B. Mosich.

The sound consists of two elements. The first element is the recordings of the sounds of bats, which humans normally cannot hear due to the sound frequencies they create. By modulating the recordings of bats, the sounds become audible to the human ear. The second element is the story/narrative/manuscript in three parts, generated by AI and edited by PI. The story is not sequential, so the participants can start and end anywhere they want. In the PI's live performance (Figures 6, 7), the three story parts were used as the basis for an improvised story.

5.1 Analysis of Techno-Lab Karasjok

The project, initiated in March 2023, involved various uses of Techno-Lab Karasjok during the same year. Techno-Lab served as an experimental space, particularly within the Sami Curator Educational program. Additionally, it functioned as a venue for exhibition communication, exemplified in workshops tailored for children. Furthermore, Techno-Lab Karasjok was utilized as a space for repairing activities.

The ongoing findings highlight the diverse applications of Techno-Lab, including practice-based activities that complement theoretical content for adults, explorative and performative space-building workshops inspired by Lena Stenberg's exhibition for children, weekend drop-in sessions, and functioning as a repairing station.

5.2 Analysis of the performance

In the presented case, AI was employed in several ways: to generate images related to bats and to write three short stories with bats as a recurring theme.

The generated images (Figure 2) can be described as a series of abstract images or collages that contain or are made up of elements or parts of images of bats; for example, bat-like wings and fur elements can be identified. The human artist then made drawings consisting of similar bat-like elements; these drawings were then screen-printed onto white fabric in a collage-like manner (Figures 5, 8, 9). On these flags, bat-like elements are still visible, perhaps further abstracted with line-art in bright colors. Also, new elements have been introduced in the form of lines and dots. The collage-like appearance of the flags was made more pronounced by the conditions in the printing studio, where the small screens necessitated repeating several smaller images to cover the large pieces of fabric.

The process of writing the textual pieces is described in the work of Griniuk and Mosich (2022) and consists of the human artist providing a number of written lines to inspire the AI. The AI then outputs further lines, which the human selects and edits. In this case, some themes were provided by the human—such as bats and shoes—while other themes—such as echoes—and connections between themes—such as shoes to a presence, bats being heard but still unheard—were created by the AI.

A more in-depth analysis could take into account deadlines, funding and monetary issues, social conditions, health, and various

FIGURE 4
From the live performance by the PI. Photo by Mikkel Kaldal.

other things. However, this brief analysis does highlight that the output from the AI becomes entangled with the output of the human, and the origins of certain ideas become difficult to map. Of note is that this entanglement happens not only at the production level but also at the conceptual level—AI output affects ideas early in the process that inform the entire concept and process. For example, the choice of a collage of parts was affected in the conceptual stages by the AI-generated images and in the production stage by conditions in the studio. The point here is that the former can be considered a creative choice and the latter one of necessity. In this way, it becomes difficult or even impossible to differentiate between creative, non-compulsory choices originating from the human or the AI.

5.3 Meta-analysis of Techno-Lab Karasjok

Much like the nuanced perspective in the discourse on AI and human interaction, the project positions Techno-Lab as more than a mere space for experimentation, exhibition communication, and repairs. Rather, it emerges as an enabler and catalyst in the creative process, to a creative assistant in the human-technology dynamic. Specifically as the extension of the communication and exhibition dissemination space Techno-Lab with the content of experimentation for example with DIY instruments within the exhibition space, ads creative dynamics which allows for exploration of the exhibition in a new way.

Techno-Labs facilities become an active participant in shaping the exhibitions communication, and outcomes. The varied applications, from practice-based activities for adults to explorative workshops for children and even functioning as a repairing station, demonstrate the dynamic relationship between the space and its users.

Techno-Lab is not merely a physical space but an active contributor to the artistic endeavors undertaken within it. This dynamic interaction mirrors the intricate dance between human interpretative abilities and technology as the added layer of enhancement of creativity, creating a space where each entity's strengths contribute to a richer, more collaborative creative process. Therefore Techno-Lab project can be discussed in the context of post-humanist artistic research.

5.4 Meta-analysis of performance

Viewing the interaction between AI and a human as merely an interaction between a tool and a creator or master greatly reduces the intricacy of the interaction. An anthropocentric view of this interaction ignores the impact and inspiration possible in the creative feedback loop (Griniuk and Mosich, 2022). Conversely, a post-humanist view would see this interaction as something that is much more meaningful than a mere interaction from the perspective of a tool and creator. It would acknowledge the potential for creative growth that can exist between the AI and

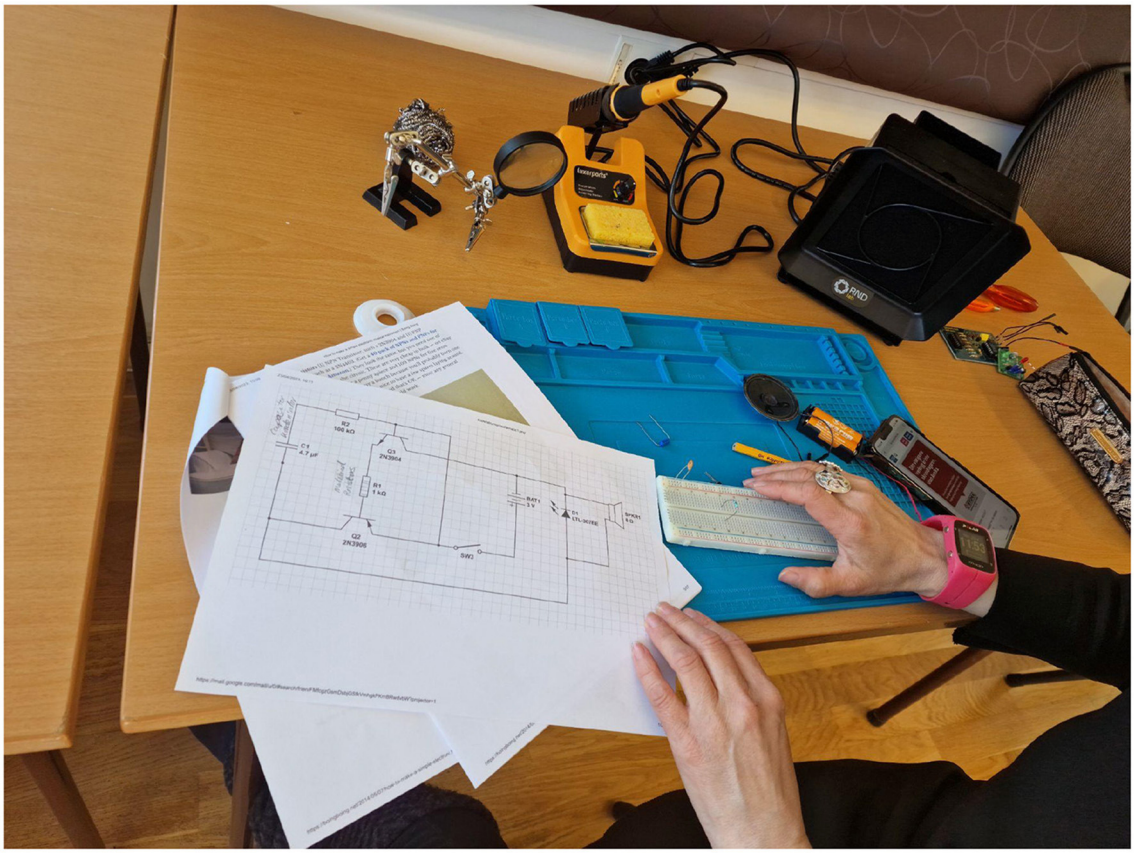

FIGURE 5
Workshop participant at Techno-Lab. Photo by Marija Griniuk.

the human creator. The AI and the human could both grow by influencing each other's creations or output. Whether this growth or feedback occurs on the smallest scale or the largest scale, the AI and the human are still the co-creators of each other's creations; they both play an active role in the creative feedback loop. As such, the AI is just as involved in the creative process as the human. In this way, the AI is much more than a tool, such as a paintbrush or a hammer. The AI is an enabler and a catalyst in the process of creation.

It does not follow, however, that AIs are creative in the same ways that humans are, nor would they necessarily need to be. In this case, the AI's role could perhaps be termed as a creative assistant as it uses data to inform and inspire the creative process.

It also does not follow that the AI possesses agency in the same way a human might. However, the AI is participating in the process of creating. Thus, the creative feedback loop occurs in this situation only because the AI is participating in the creative process along with the human. The AI, in its role as a creative assistant, then, could be seen as having agency by facilitating the creative process. If we are to attempt to understand or describe this creative process, labeling AI as a tool becomes reductive and simplistic.

The human-AI interaction can therefore be seen as a dynamic relationship between two entities, each with its own strengths and weaknesses. The human is better at interpreting and understanding data, while the AI is better at processing large amounts of data. The human is better at understanding complex ideas and abstract concepts, while the AI is better at performing specific tasks.

5.5 Critical analysis

The cases illustrates that the human-AI relationship in artistic creation is more symbiotic and complex than typically portrayed. AI is not just a tool but a creative partner that influences both the conceptual and practical stages of art-making. While AI lacks human-like agency or creativity, it facilitates new forms of creative expression through its ability to process data and inspire unexpected thematic connections. This shifts the discourse from a master-tool dynamic to a co-creative partnership that enriches the artistic process. Anyway this post-humanist creative process raises as well the questions of ethics and authorship behind the created artwork.

5.6 Perspectives in educational context

The current paper focuses on performance and technology, aligning with theoretical discussions about intelligent applications

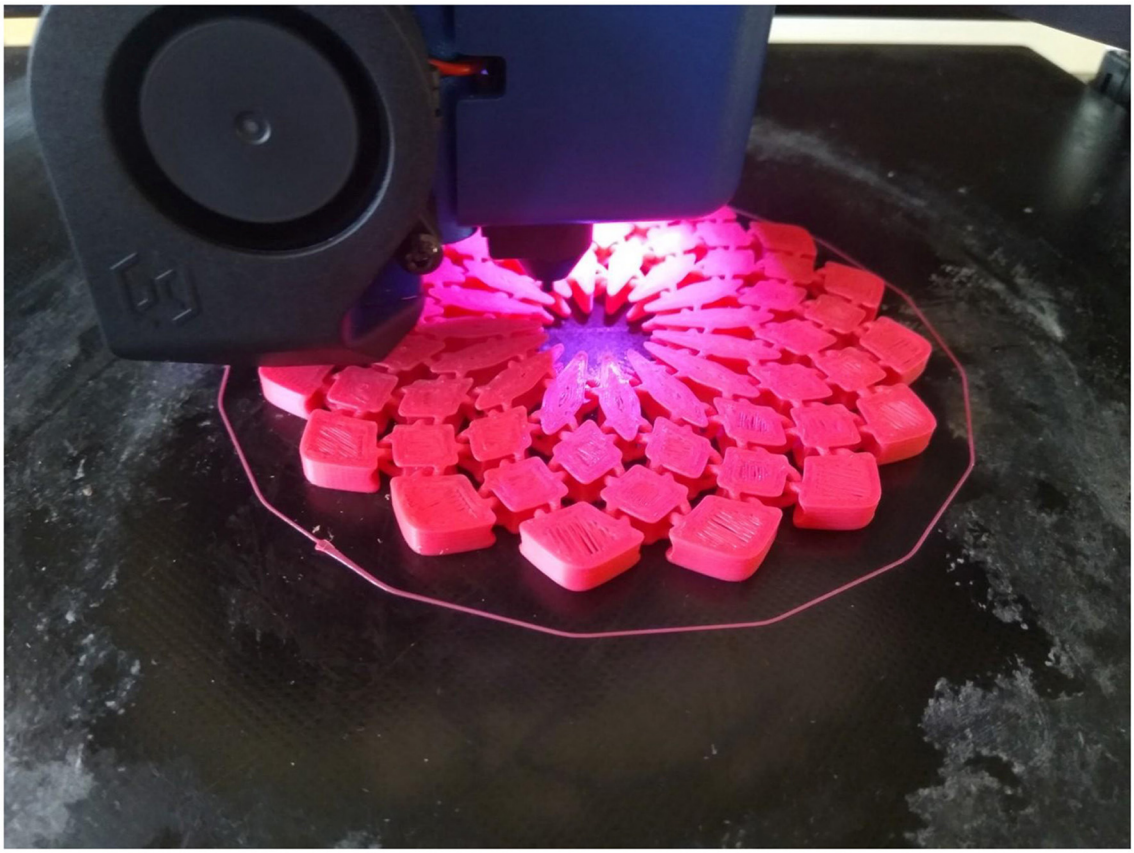

FIGURE 6
Production at Techno-Lab. Photo by Tue Brisson Mosich.

as tools for enhancing the learning process (Alneyadi et al., 2023; Tashtoush et al., 2023) and Augmented Reality (AR) as an interactive element in teaching environments (Hidayat and Wardat, 2023). It also examines the role of AI in academic settings as part of the post-humanist sphere of artistic creation. The introduction of courses that enhance students' digital literacy, consciousness, and critical thinking when working with technology—particularly AI—could address emerging questions such as authorship and law when creating the artwork involving human and non-human creators, and the ethical considerations in collaborating with non-human entities. These aspects could significantly enrich students' critical thinking skills.

6 Conclusion

This article addresses post-humanist artistic research by using performance artwork production as a research case to outline the main points of value of collaboration between humans, technology and AI and the new scale of the artistic, creative loop that such collaboration causes. The anthropocentric way of understanding artistic production needs to shift into the post-humanist perspective, as newly available technology provides new ways of experiencing creativity. Technology within Techno-Lab project and AI within performance production can be seen as an assistant that inspires and gives input, which the creative producer applies or edits and gives back to. Such production is cyclic and mutually impacts the output. The perspective of tool and creator is thus expanded to the scale of giving inspiration and being inspired as humans and technology interchange these roles. In other words, technology and AI is an accelerator of the creative process, not just a tool. Technology and AI can be interpreted as a co-collaborator and co-participant in the creative process, yet this collaboration is not equal, as the human creator makes the final decisions about the aesthetic outcome. All these points suggest that artistic creation and artistic research should be reframed in a post-humanist framework, as the anthropocentric take on these processes is no longer useful when interconnecting technology in the exhibition facilitation processes and exhibition dissemination and AI with performance. Post-humanist artistic research allows for an understanding to emerge of co-creation with technology and AI as a dynamic process between the two entities. So, post-humanist artistic research can allow for transcorporeal artistic production and could be a useful methodology, while technological possibilities expand on a level available to consumers. The findings of this research, which outlined the main points that define the post-humanist artistic research, can be useful to the art academy and university educational milieus and to artist-practitioners.

FIGURE 7
One of the screen-printed flags. Photo by T. B. Mosich.

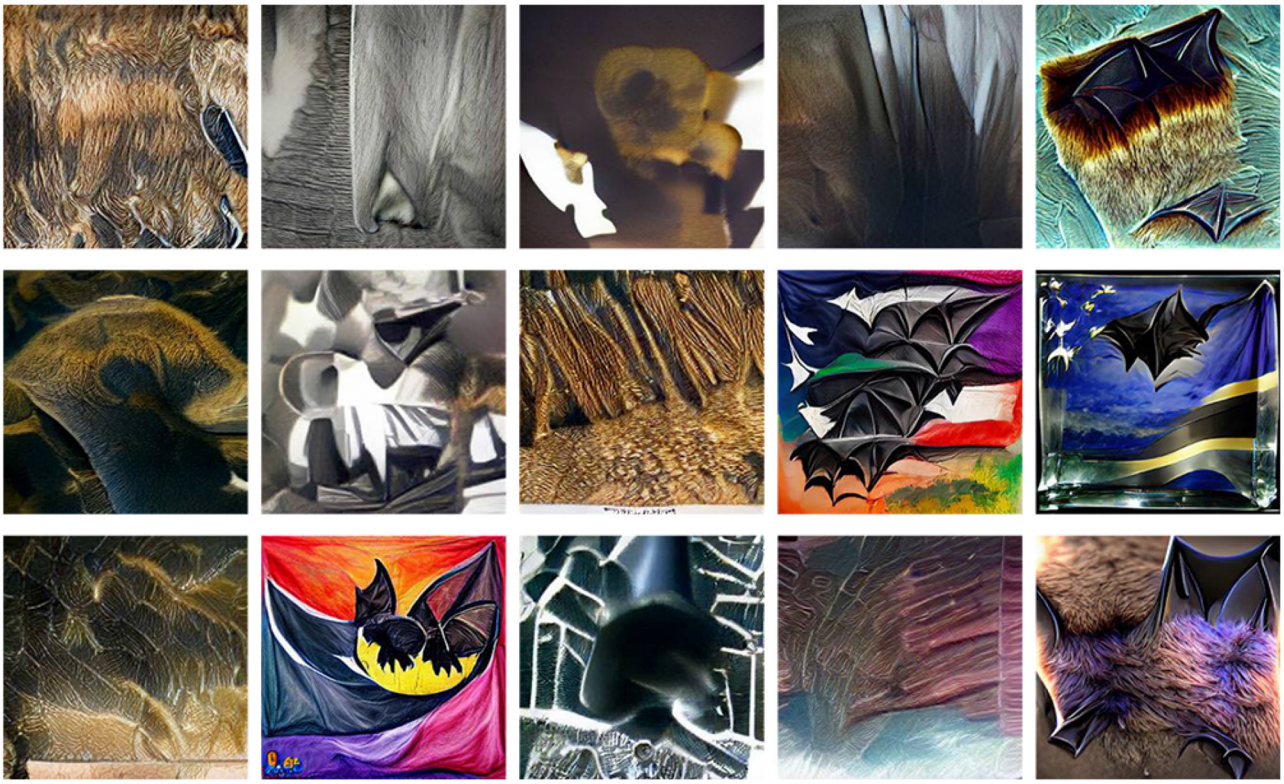

FIGURE 8
AI-generated images pertaining to bats, generated by hotpot.ai and huggingface.co.

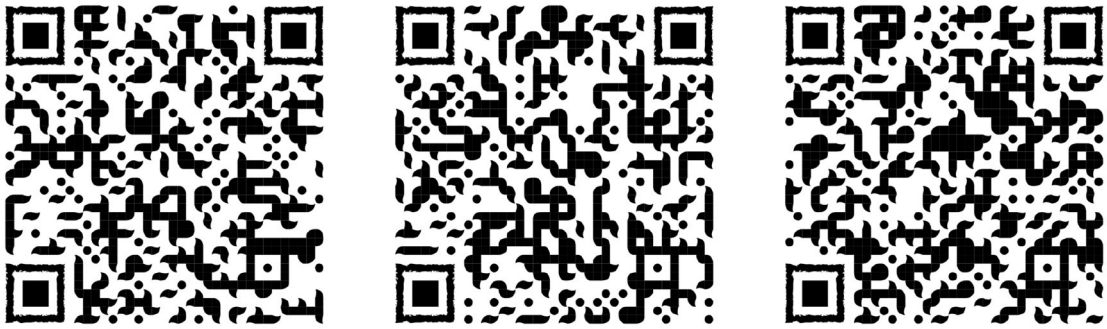

FIGURE 9
QR codes that lead to the online audio part of the work.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

MG: Writing – original draft.

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The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Visual communication through performance collaborations

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At the intersection of artistic performance, bioart, technology, and visual communication, this article explores how more-than-humans (MTHs) can be visualised, given a voice, and recognised as active collaborators in societal systems. The BioART Laboratory at the University of Lapland conducted a series of textile and digital art studies focussed on fostering shared growth and collaboration between humans and MTHs. This research aimed to investigate how active cooperation between humans and MTHs can be stimulated through visual communication and what roles improvisation, materiality, and digital technologies play in conveying such processes in a post-humanist context. To address these questions, two studies employing arts-based research were drawn from a series of studies conducted in the laboratory between 2021 and 2022. These studies examined the materiality, performative practices, and digital documentation of MTHs, employing photographic layering techniques and biotextiles. The affordances created through collaboration with MTHs for diverse improvisational and performance practices and the use of digital tools and multidimensional approaches were analysed. This analysis established a critical framework grounded in applied learning and self-reflection to better understand the contributions of MTHs to visual communication.

KEYWORDS

more-than-human, visual communication, improvisation, materiality, digital technologies

1 Introduction

This article discusses visual communicative practices and their relationships with more-than-humans (MTHs). Set in the framework of post-humanism, perspectives derived from non-Eurocentric origins remain largely marginalised. Barad's (2003) study provides critical context for the post-humanist turn and the development of new materialist thinking. Barad begins by critiquing the power of language to confer meaning and the various twists it has introduced, including semiotic, interpretive, and cultural shifts. They argue that even materiality has been reduced to a form of language or cultural representation. Our article focuses on the post-humanist and material turn in relation to MTHs. Barad (2003) emphasises that understanding performative discursive practices challenges the representationalist belief that words merely describe predetermined things. By 'performativity', Barad refers to the productive nature of actions, suggesting that performativity challenges the supremacy of language in defining reality. In our study, performances are based on improvisatory practices and placemaking.

Barad (2003) explores performativity through practice and creation, arguing that the shift from representationalism to performative alternatives redirects attention from questions of reciprocity and the correspondence between descriptions and reality to an emphasis on practices, actions, and agency. These perspectives raise essential questions about ontology, materiality, and agency, exposing the limitations of social constructivism, which operates as an endless feedback loop with no new insights. Furthermore, Barad clarifies the theory of

performativity in the contexts of scientific research, feminist theory, and queer theory. They examine performativity from materialist, naturalist, and post-humanist perspectives, highlighting the active participation of matter through the concept of 'intra-action'. This performative understanding shifts the focus from linguistic representations to discursive practices. In this article, discursive practices, such as placemaking, design, and artistic co-authorship, are shown to construct social realities that incorporate MTHs as active participants.

With such perspectives, post-humanism can evolve by encouraging the emergence of marginalised knowledge (Ylirisku et al., 2024). Our studies investigate one example of such marginalised knowledge: visual communication with MTHs. Ylirisku et al. (2024) describe post-humanism as an intersection of 'other critiques of humanism, including decolonial thought, feminism, and critical race theory, and thus attend to questions of ethics, power relations, and politics'. They emphasise that 'many Indigenous epistemologies and cosmologies never parted from the entangled view of the world, and if these views are not accounted for, posthumanisms risk becoming yet another form of colonialism' (Ylirisku et al., 2024, p. 2). A key post-humanist question is how to de-centre or deterritorialise humans, which has been critical, and consequently, how to foster alternative ways of knowing (Young and Cutter-Mackenzie-Knowles, 2020). Furthermore, post-humanism seeks to dismantle the juxtaposition between humans and nature, recognising humans as integral to nature (Sundberg, 2014). Deleuze and Guattari (1987) provide another essential perspective by introducing rhizomatic thinking, which they describe as a non-hierarchical model of knowledge creation and social organisation. Rhizomatic thinking fosters interconnectedness between ideas, identities, and social practices (Deleuze and Guattari, 1987).

Our article aimed to explore how humans and MTHs can use improvisatory processes to review and re-enact knowledge co-creation. This process involves active and enacted practices of looking, seeing, and understanding (Seymour, 2023), creating new understanding through visuality and expression in collaboration with MTHs. In post-humanist theory, creativity is grounded in Indigenous epistemologies and critiques, and it can be contextualised as universal and extending beyond human activity (Henriksen et al., 2022). Barad's (2007, pp. 128, 170, 178) concept of intra-action suggests that entities do not pre-exist in their interactions; rather, they emerge and take form through these interactions. Intra-action implies that meaning and agency emerge from the entangled relationships between subjects and objects. This contrasts with the traditional notion of 'inter-action', which assumes that subjects and objects are pre-existing entities that interact. Intra-action emphasises how entities come into being or continuously evolve, carrying profound implications for the agency. Our article also aims to expand the understanding of agency by recognising and respecting nature as a co-author in artistic practices. Intra-action suggests that in the entangled relationship between humans and MTHs, new forms of agency and authorship can emerge (Barad, 2007, p. 218). This evolving view of nature's authorship is evident in legal and societal changes, as some jurisdictions currently recognise nature as a legal subject (Pelizzon et al., 2021). We remain attentive to the inherent differences among humans, particularly in post-humanist contexts.

This article poses the following questions: How can the post-humanist turn inform design practice, thinking, and performative ontologies? How can interactions between humans and MTHs, as well as cross-species translations, impact relationships such as co-authorship? How can these relationships be visually conveyed to raise awareness of human boundaries? Our article addresses these questions through two artistic studies, focussing on experiencing the natural environment and recognising diverse species as authors (Sheber, 2020). These studies emphasise visually representing place, respecting placemaking, and recognising nature as an artistic author. Arts-based research (ABR) was used to study the role and agency of MTHs (Miettinen et al., 2022). For example, Deleuze and Guattari (1987, p. 80) propose the concept of assemblages as complex networks of heterogeneous elements in which both humans and MTHs can exert agency, create new formations, and shape social realities. Assemblages underscore the interconnectedness of cultural, political, and social factors, providing insights into complex systems (Deleuze and Guattari, 1987).

The two artistic studies conducted at the Bioartex Laboratory at the University of Lapland employed an ABR strategy to explore MTH and human performances (Leavy, 2017). Study 1, 'Filming Placemaking Through Performance', explores the relationship between improvised performance and the affordances offered by natural environments. This study investigated the human–environment relationship in an art- and design-based context. Study 2, 'Roots Stitching', explored bioart tapestry-making and how its performative aspects can enable co-authorship between MTHs and artists. Härkönen et al. (2023) analysed 'Roots Stitching' from a legal and copyright law perspective, focussing on the temporary nature of the growth of the seedlings. The process involves transforming fleece into a tapestry by stitching fibres into a mat. From an artistic performance perspective, the growth of seedlings can be viewed as a form of artistic activity, which is comparable to traditional artistic performances (Härkönen et al., 2023). Usually, an artistic performance ends when it wraps up with the last tone or movement. Similarly, in tapestry-making, the growth of the seedlings halts and dries out during the final stages of the process. Both activities are, however, driven by human action and interpretation, but in the case of tapestry, MTHs act in collaboration with humans.

Both studies generated new meanings and knowledge through co-authorship and visual communication with MTHs. Liebenberg (2024, p. 115) emphasises the urgency of finding 'new ways to talk—through image, text, and objects—about human–plant relationships' and broader MTH–human interactions. To address this, this article employs photography and video for documentation and visual communication. A critical view on the use of various forms of visual documentation is presented by Sontag (2018), who cautions that 'pictures do not speak for themselves; they need a historical and geographical context'. Such critical views are considered in both studies.

Kelly et al. (2020) argue that visual elements have become the primary means of conveying information in contexts such as media, social media, and education. The complexity of these multi-contextual applications underscores the need for visual literacy to critically interpret images. Visual communication facilitates understanding with the help of visual images in an increasingly digital world (Josephson et al., 2020). Sontag (1977) explored how photography shapes our sense of reality, engagement with the world, and perception of events. She posits that while photography can reveal truths, it can also alienate us from reality, urging artists to be cautious in interpreting

and communicating reality through visual means. Sontag (1977, pp. 174–178) calls for a critical approach to consuming images.

Creating photographic and visual images with MTHs contributes to understanding social reality. Moriarty and Barbatsis (2005, p. xiii) assert that visual communication cannot and should not be confined to a 'unifying theory' 'because it represents the intersection of thoughts from many diverse traditions'. As a starting principle, visual communication entails conveying, representing, and interpreting visual elements to communicate concepts and information. At the same time, it unites individuals without requiring a shared spoken language, enabling them to create common experiences and emotions (Günay, 2021). Design, as a visual language, uses visual cues and components to convey messages or address problems (Günay, 2021). Through visual communication, we can contribute to inclusion, exclusion, and agency; therefore, this article uses visual communication to challenge and reconsider human agency in interactions with MTHs.

2 Theoretical framework

The theoretical framework is constructed through artistic co-authorship and placemaking with MTHs in the natural environment and at the Bioartex Laboratory. Both artistic co-authorship and placemaking are visually communicated. This laboratory focuses on developing new knowledge about bioart by creating activities that combine bioart, fashion and textile art, creative research (using arts-based methods and ABR), biotechnology, and science. The physical laboratory is in the Faculty of Art and Design at the University of Lapland, but its research connects diverse natural environments in Finland and globally.

McEwan (2023) raises the question of how to ethically engage with proteas, endangered wildflowers in South Africa, where human livelihoods are prioritised in policymaking. She aims to investigate the possibility of dialogue between humans and MTHs and to enable the agency of proteas in multispecies storytelling. McEwan examines phytography, which enables visual communication by studying plants by means of writing or photography. This article investigates similar relationships, especially how co-authorship and placemaking allow artists to visually communicate with and about MTHs in the natural environment or the Bioartex Laboratory. Haraway (2007) investigated how narratives and storytelling are the focal points in understanding and communicating complex species interactions. Additionally, Haraway (2007) suggests that diverse narratives are needed to recognise many voices in ecological dialogue. Furthermore, she reminds us of ethical considerations and our responsibility towards non-human life. Connecting to these different views, this article draws from artistic co-authorship and placemaking to explore visual communication through performance collaborations.

2.1 Design and artistic co-authorship with MTHs

'Design for more-than-human futures is an invitation to travel new paths for design framed by an ethics of more-than-human coexistence that breaks with the unsustainability installed in the designs that outfit our lives' (Tironi et al., 2024, p. 2). The transformative times we live in require more radical approaches to design that can enable the exploration of alternative ways of life. As Tironi et al., (2024, p. 2) posits, 'design cannot be a mere spectator, nor can it continue to replicate clientelist and instrumentalist strategies for relating to the world' by 'rethinking our anthropocentric inheritance'. Humans should reflect on their transformative capacities, turning their detrimental impact into working with nature and enabling the agency for MTHs.

Artistic co-authorship with communities, past and present artists, or MTHs contributes to plural design by providing new views and ways to create authorship in a post-humanist society (Bacharach and Tollefsen, 2015). Natural resources can contribute to designing a more inclusive society that strives for activism and more political agendas. Nature is increasingly recognised as an author in scientific publications, such as Martuwarra RiverOfLife (Pelizzon et al., 2021) and Wann Country (Foster et al., 2020). Similarly, co-authorship with nature through the arts can create radically new ways of investigating ethical and copyright questions by offering alternate views, but more research is needed. Hick (2014) studied co-authorship and multiple authorship in artistic practice, but the role of plants, animals, and other non-human entities remains underexplored and warrants further investigation.

Mitchell (2010, p. 11) defines bioart as a 'medium' offering conditions for emergence through processes of biological mutation. Biotextile is defined by Plank (2020, para. 5) as 'biofabricated textiles [that] are materials grown from live microorganisms'. The performative aspects of this biotextile were explored by Härkönen et al. (2023) from a legal and copyright perspective. The analysis described bioart as a performance, as the author was not wholly in control throughout the creative roots stitching processes. In its living form, the authorship of the biotextile belongs to the seedlings who stitched the tapestry. In a later stage, after the seedlings have died and the biotextile emerges in its dried state, the authorship of bioart may transfer at a later stage to the bioartist.

2.2 Placemaking with more-than-humans

Placemaking relates to urban design and the inclusion of communities when co-designing or performing. In recent years, placemaking in natural environments and rural communities utilising performance and other arts-based methods has been studied (Björn and Miettinen, 2024; Björn et al., 2023). Humanistic geographer Relph (1976) provided an analytical account of place identity, drawing on personal experience. Place-based identity unites a place's affective and cognitive aspects (Paasi, 2003) and is, like gender or social class, a substructure of self-identity. Creative placemaking and place-based art have evolved to become social, economic, and culturally empowering art forms that place artists and arts workers at the centre of their communities. As a result, artists have become proactive protagonists as to what communities, not governments, can accomplish through the arts (Grodach, 2011). Documentary films can be used as tools for creative placemaking (Plow, 2015).

The goal of placemaking practice is to go beyond the 'tourist gaze' (Urry, 1992). Place-based arts adopted a deep consideration for 'place ethic', which demands respect for any place that reaches further than merely drawing aesthetic inspiration derived from what is known as the 'tourist gaze', which often results from a superficial and short-term

interaction with a place (Lippard, 1997). Thus, place ethics considers the cultural value of a place, acknowledging that it is deeply rooted in cultural meanings and traditions that are often rendered invisible or silent due to the hegemonic forces at play. Björn and Miettinen (2024) discuss place-based arts and service design that engage with place ethics in the context of artistic cartographies. Through these approaches, the authors explore new materialities, methods of self-presentation, and ways to consider the cultural significance of a place. They propose that artistic cartographies and placemaking offer valuable means to acknowledge and preserve the deeply rooted cultural and natural meanings and traditions of a place (Björn and Miettinen, 2024).

A critical view of traditional placemaking highlights its reliance on community consultation and local stories while still operating within colonial conceptualisations of the 'site' (Foster et al., 2020). These authors explain that the concept of a country includes the ecologies of plants, animals, water, sky, air, and all aspects of the natural environment. Björn et al. (2023) have explored placemaking as a place-specific approach to service design that engages reflexivity, knowledge-sharing, and epistemology towards non-humans, for example, plants and the surrounding environment. Placemaking can help identify place-related values, such as appreciation of nature and culture, through service design.

3 Methodology

Hultin (2019) reflects on the researcher's role in a world constantly shaped by socio-material practices. He aims to understand how the ontological position underlying the socio-material approach relates to epistemology and how we can act more creatively and responsibly as socio-material researchers. This research design utilises the premises of creativity and responsibility.

According to performative ontology, knowledge and meanings arise from actions and relationships. Material elements play a role in the production of knowledge. Therefore, it is essential in research to consider social and material relationships and to understand that the research process should be viewed as an active process and a network of relationships. Phenomena should be examined as dynamic and relational, using research methods that consider context, relationships, and materiality. Such methods include ethnography and participatory observation. The active role of the researcher influences research, knowledge creation, and sharing (Hultin, 2019).

Our research emphasises epistemological practices rooted in relational and performative ontology, highlighting the dynamism and diversity of knowledge. According to relational ontology, knowledge is context-dependent and shaped by social relationships and interactions (Hultin, 2019). Our interactions are with MTHs in our artistic practice. However, according to performative ontology, knowledge does not passively reflect reality but is generated through agency and relationships. Some epistemological practices include participatory research, ethnography, interaction, and a research process allowing reflection and adaptation (Hultin, 2019).

We employed ABR to generate new knowledge through the lens of the post-humanist material turn and performativity (Barad, 2003). Methodologically, our article reflects on two artistic studies: (1) Filming "Placemaking Through Performance" and (2) Roots Stitching. The research strategy employed is ABR, an overarching research approach that includes various art forms, genres, and practices (Leavy, 2015). However, it is important to acknowledge that ABR takes place in the post-human context. ABR is also a hybrid and practice-based methodology (Sinner et al., 2006) that often leaves practitioners in the 'in-betweenness' of 'knowing, doing and making' (Pinar et al., 2004), contributing to performative aspects. Art-making processes have a strong potential to generate knowledge that may be used and applied by the makers and researchers of artistic practice, thus transitioning from tacit and implicit to explicit. This premise is the basis of practice-based (or practice-led) and artistic research (e.g., Koskinen et al., 2011).

We relied on the art-making process with MTHs and independent artistic works. The artistic processes incorporated arts-based methods, such as improvisation, intuition, performance, and photography. ABR can cultivate empathy and self-reflection by disrupting dominant narratives through performance and storytelling (Leavy, 2017). The research design employed an iterative strategy based on learning from one's research process and findings (Thomas and Rothman, 2013). New theories, artefacts, and practices were produced as an outcome of the research design process (Barab and Squire, 2004). The two artistic studies demonstrate how MTH and human interaction can be visually communicated to contribute to inclusive, reflective practices. The analysis aimed to provide a structured critical framework for active collaboration between humans and MTHs and how humans can deterritorialise representations through visual communication. Observations, digital film, and photo documentation served as essential data analysis methods. Additionally, interviews with performers, conducted as part of a focus group discussion, were incorporated into the placemaking through Performance study, specifically a focus group discussion. A detailed discussion of Studies 1 and 2 will further elucidate these findings (Table 1).

3.1 Study 1: filming "placemaking through performance"

Study 1 draws on the study by Pink (2008), who explores sensory sociality and its role in placemaking. Pink (2008) argues that focussing on place invites ethnographers to conceptualise how embodied beings are differentiated by gender, generation, class, race, ethnicity, and more. The researcher and the researched are jointly present in a

TABLE 1 Research design.

Research design		
Studies	Study 1: Filming place making Through Performance	Study 2: Roots stitching
Research strategy	Arts-based research	
Approach	Ethnographic place making (Pink, 2008)	Multispecies ethnography (Kirksey and Helmreich, 2010)
Methods for data collection	Focus group (57 min), observations, and fieldnotes	Observations (12-week period)
Documentation	Digital video and photograph	
Data	Visual data (photograph and video), interview data, notes	
Analysis	Visual and thematic analysis	

simultaneously experienced and constructed place. Walks and routes connect us to the processes of placemaking. Pink uses both the walks and the routes to question whether the ethnographer and the researcher are also participants in placemaking and whether ethnographic research can be examined from the perspective of placemaking. Study 1 connects ethnography and placemaking through observations, notes, and interviews. Pink (2008) describes ethnographic placemaking as a crossroads of direct experience and its reorganisation. In this context, memories are emphasised alongside systematic material analysis. Pink suggests that theorising common ethnographic methods through placemaking generates an understanding of how people construct urban environments through embodied and imaginative practices and how researchers create ethnographic places (see Table 2).

Study 1 is based on the video 'placemaking through performance', which includes several artistic video processes. The placemaking performances were conducted with groups of women. The author (she/her) had a long-term relationship with the women in different roles, such as colleague, thesis supervisor, and friend. There was familiarity and care when documenting the performances (Sarantou et al., 2021, 87–89).

Filmmaking is used as a means of visual communication. Carbonell (2022) studied a new mode of filmmaking called multispecies cinema, which is an attempt to experience MTHs through the use of different senses, such as seeing, hearing, and feeling, providing a means for understanding the ecosystem in flux. Barad (2017) discusses spacetimemattering, marking the inseparability of space, time, and matter. This verb stands for the relationalities of moments, places, things, and the intra-actions that configure and iterate them. The video format can enable spacetimemattering to represent the role of material in constructing reality. Time and temporality can be manipulated in the video. It enabled the artists to visualise and communicate several positions and even render the past and present into the same frame (Sinquefield-Kangas et al., 2022).

We examined the idea of placemaking and performing in a natural environment and through embodied experience. Filming 'placemaking through performance' involved artistic processes using photography, video, and performance to design, test, and iterate new artistic ways and meanings for placemaking and create artistic performances in the natural environment. The idea of performing and performance developed through several embodied studies through working intuitively in a natural environment during the shooting sessions. In our artistic processes, placemaking provides storytelling and performance channels to create the personal understandings and meanings of a place. The artistic research process included critical thinking and evaluation of the meaning and contents (Henke et al., 2020) of the artistic process (see Figure 1).

In the top right image of Figure 2, the performer traces the lifelines of the granite engraved in the rock bed with her feet. The performer honours the temporal dimensions of the stone and its enduring interconnectedness with the culture and stories of the local community that lived on Vänö Island in Finland. The bottom centre image (Figure 2) illustrates that the performance is about the physical burden placed on the performer by dragging a bundle of chopped wood in the perpetual shape of an enigma. Performance signifies providing resources often exploited by human-centred and consumer existence. In addition, the performances interacted with nature, as the affordances of the natural environment—such as the hard rock surface and soft snow—both enabled and, in the case of the snow, restricted the performance due to the heavy wood bundle.

3.1.1 The scenes of "video placemaking through performance"

The scenes in this video address several topics, including the role of women and the feminine connection with the natural environment. For example, the starting scene is improvised around a warrior Viking woman's burial. The next scene is about the female connection with the rocks, with a woman walking along the lines on rock surfaces, following the lifelines in nature. The viewer may feel grounded by the rocks and connected to them.

One of the topics explores a performance within the space of a sauna in northern Finland, specifically a wooden, heated sauna. The project explored how diverse feminist perspectives can be adopted in photo documentation, including in fashion photography (Sarantou et al., 2021). Many performers participated in producing these scenes, adding layers of meaning. For example, some performers used intuition and improvisation while wearing Sarantou's Water Waisted fashion collection. The artist herself wore the collection for sauna performances in the subzero temperatures of Pyhätunturi. Artistic processes overlap and develop in self-expression and meaning throughout the video project. Sarantou's comment in this video, 'I'm running out of water', creates several meanings. Having no water to pour on the hot sauna stone or the global drought and lack of water in

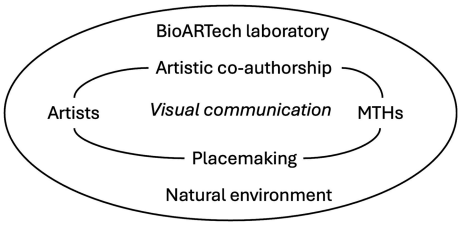

FIGURE 1
Theoretical framework.

TABLE 2 Visual analysis frameworks.

Visual analysis frameworks and sources	Visual analysis of composition (Seymour, 2023)	Analysing visual frames (Rodriguez and Dimitrova, 2011)
Phase 1	Identify: How are art elements like line, form and colour used?	Visuals as literal representations
Phase 2	Describe: How does the composition come together?	Visuals as stylistic and semiotic systems
Phase 3	Connect: How does it relate to the subject, creator, or history?	Visuals as sources of implied meaning
Phase 4	Interpret: What does it express, and how do you feel about it?	Visuals as reflections of ideology

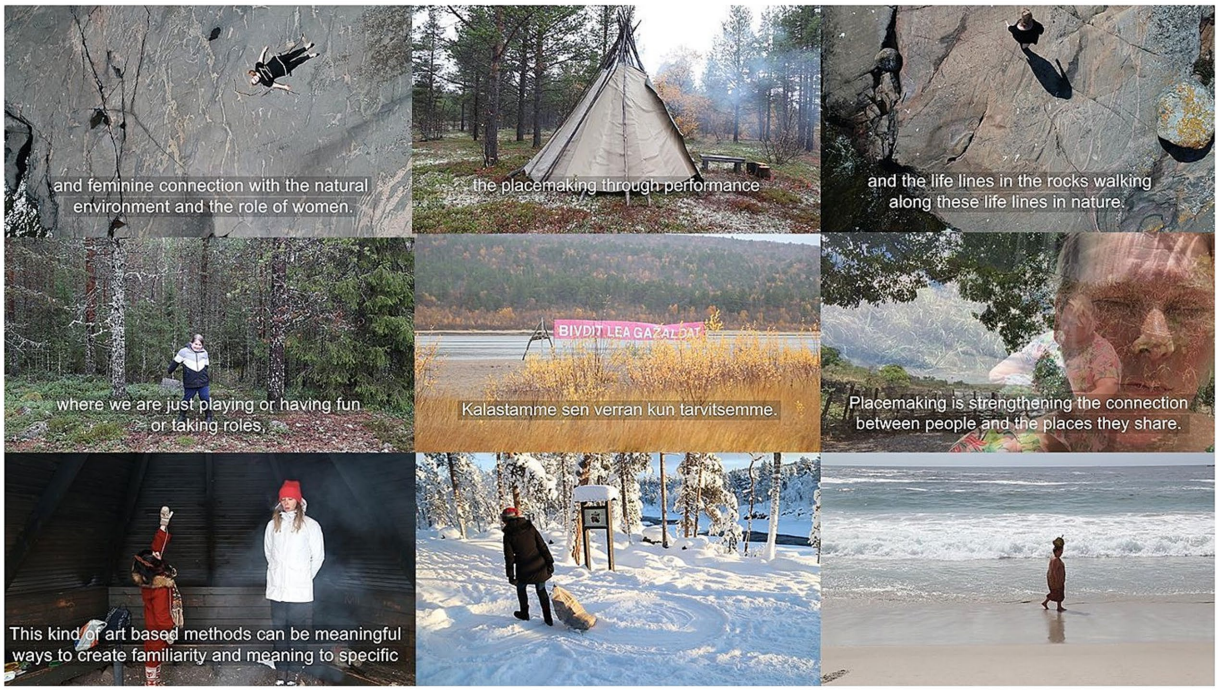

FIGURE 2
Images from the placemaking through performance video. Videoart by Satu Miettinen Miettinen et al. (2022).

the desert regions, the author is familiar with experiences in Namibia and South Australia, which inspired the fashion collection.

One of the scenes in the video shows how children and adults can engage in both realistic and imaginative play in forests (Miettinen and Sarantou, 2021a). Washinawatok et al. (2017) explored children's sensitivity to ecological relations when engaging with forests. This exploratory play can also be performed in or with the natural environment. Some of the locations in the video are very familiar, for example, the forest close to Miettinen's house in Korkalovaara, where she played, trying out different things, having fun, and assuming roles.

Scenes four and five are called 'Jäniskoski Improvisation' and 'Caressing the Stones'. Care and caressing are topics connecting performances in these videos. A performer caresses the lávvu (fireplace in the Northern Sami language) while considering protecting this wooden structure that provides continuous groups of people. Another scene shows the author caressing the river stones with a brush. These scenes were produced in the context of the project Dialogues and Encounters in the Arctic, a project funded by Interreg Nord and the Lapland regional council. The project was led by the Sámi Education Institute (Finland), with collaborators such as Umeå University (Sweden) and the University of Lapland (Finland). We refrain from using the term 'Lapland' in this article and instead refer to specific place names. Challenges are presented with the names of locations, especially when using the English language, because in the Finnish language we use the term 'Lappi' which is a little less problematic than its English translation Lapland. 'Lappi' refers to the administrative region of Northern Lapland, which is a larger geographical area than Sápmi, the homeland of the Indigenous Sámi people (Tervaniemi and Magga, 2018). Both the terms Lapland and 'Lappi' are still complex questions. The use of names in this context warrants a much broader discussion, which cannot be accommodated due to word count limitations. However, readers can refer to works such as Moran (2012, p. 5) for further insights. In addition, a recent discussion by Sámi activist Laiti (2025) provides valuable perspectives for those seeking additional references. Author Miettinen is located in 'Lappi', northern Finland, just outside of Sápmi. She recognises and acknowledges the Indigenous lands and strives to approach placemaking on these lands with care (Miettinen, n.d.). However, such acknowledgements have been criticised as having little more than ceremonial value (Dreyfus and Hellwig, 2023). The sixth scene, 'Salmon War', presents ephemeral textile art and activist performance art aimed at protesting the legal sanctioning of a Finnish environmental graffiti artist advocating for action against the disappearance of salmon from the Kemi River in northern Finland (Miettinen and Sarantou, 2021b). Activism, or artivism, is one of the essential topics of video. In this performance, we embody Indigenous salmon in the Kemijoki at Tervakari, conveying the struggle of swimming against the current in the Kemijoki.

In addition to these six artistic and performative processes, the 'Placemaking Through Performance' video includes short video segments of placemaking performances from different natural environments in Victoria Falls in Zimbabwe, Camps Bay Beach in South Africa, and various locations in Finland: Pyhätunturi, Tenojoki, and Pulmankijärvi. Some video sessions are autoethnographic, such as She Santa at Kemijoki or a portrait at Victoria Falls, affording opportunities for different alter egos or roleplays in the performance. She Santa tells the story of a female Santa who promotes emancipation and environmental values. Autoethnography gives space for thinking about one's personal history, the complexity of relationships, and connections with environments. The video includes narration that explains "placemaking through performance."

3.2 Study 2: roots stitching

Roots Stitching was a collaborative work between the sunflower seedlings and Sarantou. This section reflects on the biological agency of sunflower seedlings growing on a woolbed. These studies were conducted in various locations from Finland, Australia, and Japan, and they yielded different results based on the environments in which the seedlings performed their rhizomatic root growth to connect different layers of wool. The seedlings were provided with wool to perform stitching with their roots to create the intricate textures of a wool tapestry. Sarantou is a Namibian-born Australian who worked in academic contexts in Finland and, more recently, in Japan. In all the places she has lived, her bioart and root tapestries assist her in exploring rootlessness resulting from migration.

3.2.1 Multispecies ethnography, observations, and performance

Peers et al. (2022, p. 18) refer to deep visiting as a collaborative autoethnographic methodology for mutual flourishing. They describe deep visiting as 'mutual receptivity, cultivated, slowly and softly—through deeply intersectional and accessible visiting—across what was, what is, and what may yet become'. The concept of deep visiting is to spend time with one another and with research participants in affirming the processes of renewal. The research with Sunflower Seedlings was a multispecies ethnography that can be understood as ethnography practised with human and non-human species (Kirksey and Helmreich, 2010). This field of research practice emerged from three areas: animal, environmental, and science and technology studies (Kirksey and Helmreich, 2010). The ethnography was based on observational and digital documentation practices, where the deep visiting of the artist-researcher with the sunflower seedlings grew into an intimate understanding of the growth and meshworking of the seedlings. Additionally, the multispecies ethnography practised in this way aligns with Pink's (2008) visual ethnography.

The mono-directional observational relationship requires acknowledgement, yet at the same time, deeper implications for (artistic) performance became evident through the observations by the artist-researcher, which implies the seedlings had an audience (apart from being exhibited at the Gallery Hämärä at the University of Lapland in 2022). Davies (2011) implies that performance itself may be an artwork when contextual properties, such as representation and expression, form the artistic content of the study. However, performance may also refer to improvised studies in which the doing of the artwork answers these contextual properties, such as a jazz performance. Moreover, a performance can play a key role in appreciating a larger artwork by being one of many possible versions of it (Davies, 2011). Biotextile tapestry, classified as bioart, can be seen as a product of performance. Given the representational and expressive contextual qualities of stitching the lambswool and representing the stitched actions through their root meshwork, it may also be an improvised art.

3.2.2 Photographing performance by MTHs and biotextile roots stitching

The image on the right of Figure 3 depicts the stitching of sunflower seedlings. The image on the left (Figure 3) represents the digital manipulation of documentary photography to visually communicate, recognise, and acknowledge the inscriptions of the root network and the surface texture and traces (Ingold, 2018) of their performance in the woolbed. The surface traces only partly communicate the depth and labour of the performance, as several layers of hidden activity lie underneath the surface of the tapestry.

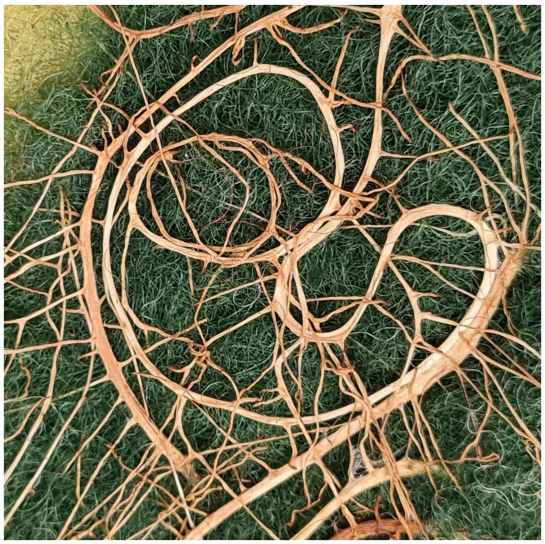

FIGURE 3
Co-authors of the bioart, sunflower seedlings, 'perform' the process of rhizomatic growth by stitching layers of Finnish lambswool into textiles resembling a tapestry. Photograph printed in Härkönen et al. (2023).

The biotextile, represented by the dried tapestry (Figure 4), illustrates the root network in a transformed state: dried and browned, in contrast to the green woolbed. Here, the sunflower seedlings have become part of the materiality of the biotextile after their live performance. They are the surface texture and traces within and of the materiality they represent. This bioart visually communicates the fragile interconnectedness of the roots and the wool and the beauty of endings and histories. The biotextile does not visually communicate the superficiality of the surface (see Ingold, 2018, p. 137), but rather the depth of life, labour (of love), and the transformation of meshworking through the woolbed. The biotextile also communicates co-authorship with MTHs.

Documentation of research processes through photography can be interpreted as performance, as explained by Holm (2008), who has used photography to document ethnographic research since the 1990s. In this context, performance serves as both a method of exploration and a means of representation. The researcher works closely and collaboratively with participants throughout the research and its representation, creating a process that can be viewed as a shared performance (Holm, 2008). The photographic documentation of the growth and development of the biotextile through observation (through a lens), and as a collaborative process and deep visiting (Peers et al., 2022) between the Sunflower Seedlings and the artist-researcher, can be interpreted and described as a performance.

3.3 Analysis

The analytical approaches used in this article are visual analysis (Studies 1 and 2) and thematic analysis (Study 1). Visual analysis

FIGURE 4
"Roots stitching" bioart tapestry, co-authored by the sunflower seedlings and the author Sarantou. The biotextile is the result of the performance of bioart in its dried state. Photography by Melanie Sarantou Sarantou and Miettinen (2022).

examines visual elements such as line, colour, shape, and composition to understand the meaning, function, and impact of a work. It systematically considers context, purpose, and symbolism to deepen our understanding of visual representation, whether art or design. Drew and Guillemin (2014, p. 54) propose the interpretive engagement framework, which consists of five elements: the researcher, participant, image, context of production, and audiences. These elements each make a unique contribution to visual analysis, but when applied as a systematic analytical approach, they can, in combination, significantly contribute to the entire analysis.

Seymour (2023) explains the process of visually analysing the composition of artworks or photographs. The process is inspired by the studies by Fry (2018) and Bell (2019), who summarise how art and photographs can be interpreted in four steps: identification, description, connection, and interpretation. Rodriguez and Dimitrova (2011) propose a similar visual analysis method, a four-level framework for identifying and analysing visual frames in which each level explains and seeks to identify unique points of view within that visual frame. Their frameworks can be used to analyse a variety of visual media or how audiences interpret them. Both indicate the systematic use of visual analysis processes in which different phases lead to gaining more comprehensive insights into the artwork or photograph.

Both frameworks are informative and have been used in the visual analysis in Studies 1 and 2. For example, in roots stitching, the analysis compares how art elements changed over 12 weeks to identify the performance of the seedlings, which enabled the artist to describe how the composition of the meshwork developed. The meshwork was created in the history of placemaking in the Bioartex Laboratory and the interactions between the artist and seedlings. On an emotional level, the interconnection between the meshwork and the artist evolved, at least for Sarantou, who experienced emotional stimuli from the developing meshwork, the slow creation of the changing colour palette from growth to demise of the seedlings.

Thematic analysis was used to analyse the transcribed data from the focus group. This analytical method identifies and analyses patterns of meaning within a dataset (Joffe, 2012). It highlights key themes significant to understanding the phenomenon being studied, ultimately showcasing the most prominent meaning of the data through clusters of similar or opposing data, which is used to constitute new themes. As Joffe (2012, p. 209) explains, 'a theme refers to a specific pattern of meaning found in the data'. The transcribed data from the focus group interview were analysed by clustering similar content under new themes, such as placemaking and agency; while performing and documenting these performances, the natural environment and its forces impacted how and when to visualise them.

4 Findings

Placemaking in the natural environment is sensitive to co-authorship with the natural environment. The affordances in the natural environment create a deeply sensory space where we experience the geohistorical and a connection with a living ecosystem where both humans and non-humans belong. Placemaking is also used to revitalise one's connection with the natural environment. Sometimes, there is a need to feel the connection through family-owned land. Sometimes, family grounds are lost due to conflicts, changes in the borders of nation-states, or new policies. The natural environment can enable grounding through familiarity with the location and create a healing or nurturing experience. For example, bathing, floating, or swimming in moving water, such as a river, will co-author the experience and profoundly impact embodiment and sensory place. Filmmaking used for visual communication can make this co-authorship with the environment more available for the audience. Filmmaking enables seeing, feeling, and showing, as it helps represent embodied, multisensory experience and reflect this (Paterson and Glass, 2020). Filmmaking can make co-authorship with MTH more visible when using moving images and soundscapes.

Placemaking as a co-authoring practice can interact with the idea of different cosmologies, such as the planet's origins, which Mignolo (2018) discusses. Placemaking also attempts to open us to the possibility of accepting affordances in nature and their impact on shaping and co-creating our experiences and emotional space.

Spacetimemattering through video helps in understanding the agency of the natural environment through its movements, such as the flow of the sea or the soundscape of the waterfall. Both of these can participate in the narrative of the performance by watering or moving the performing body in the direction it wants, such as in the placemaking scenes in the natural environments at Victoria Falls in Zimbabwe or Camps Bay Beach in South Africa. The natural environment and forces impact cinematography. The opening scene of the placemaking video was filmed with a drone camera, which was possible only when it was not too windy. This is a testimony to the agency of the natural environment. Following the weather created an intense dialogue with the natural forces.

4.1 Performing in the natural environment

Performance through placemaking is an artistic practice in which one uses one's creative potential to move one's body through the feelings, emotions, and memories that one senses from a particular place, such as a natural environment. These movements can fill a small or large space, be enacted with natural elements such as trees or water, and engage available objects. Performance through placemaking is place-specific and embodied (Wilbur, 2015). Placemaking strengthens the connection between people and the places they share. Placemaking is needed more and more because people are dislocated or newcomers to different places. Therefore, it is essential to create new strategies for people to feel a meaningful connection between each other and the places they share. We may change the places in which we live several times. Hence, we lose the traditional knowledge stored by our parents or grandparents, such as how to find mushrooms, how to find blueberries in the nearby forest, or how to familiarise ourselves with natural landmarks. These art-based methods can be meaningful ways to create familiarity and meaning with specific locations and connections between places and the people sharing them. Artistic processes around placemaking create feelings and memories of strong intergenerational connections with particular locations, and these can carry immense meaning for placemaking and connection with the place (Rico and Jennings, 2012).

> *It was the whole trip—somehow driving this way and seeing all the colours, lights, and sceneries was pretty important and amazing. Somehow sensitising you all the time that, okay, you are seeing something, and then more and more. I think it was significant to see those birds flying. This riekko (willow grouse). I felt it's somehow mystical how the land and the sky somehow mixed.* (Excerpt from a group discussion, 2021)

This artistic research project explored the role of human and non-human agency, interaction, and temporality in performance and the environment. Artistic action can connect our bodies with the surrounding ecosystem and remind us of this connection—being embodied and part-of-nature creatures (Gibbs, 2014). Some of the performances are in new locations where one is trying to make sense, create meaning, or develop respect for the place, such as Victoria Falls, Cape Town, or other locations that one wants to preserve and protect. These embodied and artistic interactions create new affordances for performing in and learning about the natural environment. Placemaking could be used to revitalise the earth's connection and ground us. Some locations, such as Pulmankijärvi, have unique biodiversity. Sense can be enhanced through placemaking, and performances can bring together true and imagined stories through the signs and signals observed in a natural environment.

> *I realised it was so important to be there and enjoy that incredible landscape that it was the moment where I should put things out of my mind and just focus on being there. Because it was so incredibly special.* (Excerpt from a group discussion, 2021)

Artistic research and artistic thinking are used in several ways during the process: performing; documenting; creating photographs and videos; narrating the performances; discussing the processes; opening up spaces for improvisation, iteration, and interpretation; and creating meaning for the "Placemaking Through Performance."

> *It looked flat. You couldn't really know how deep the snow was, so as I started interacting with the snow and walking, I realised it was deep. Then I started thinking, oh it's hard, and then I started thinking about this metaphor that I explained earlier. But I was impressed by how quickly you start getting these thoughts, images and ideas. But in a way, using art-based methods is also a more embodied experience to generate ideas. It just happens.* (Excerpt from a group discussion, 2021)

Placemaking through performance is a process. We are still investigating, studying, and figuring out all kinds of meanings relating to it, including what can be done with it and what kinds of contexts it can be applied to. It has already proved its potential, and we are continually working with it. Filmmaking can help the audience understand the process and utilise their senses when spectating. The idea of the project was to present feelings related to the natural environment with embodied actions and movements through performances in specific places that felt special and specific. The places were selected intuitively. This embodied performance sensitised us to the location so that we could hear, see, smell, listen to, and feel the natural environment. Using all the senses is integral to performing in a natural environment. Doing so enables the discovery of affordances, sensitising oneself to create connections with past generations and co-authoring with non-humans such as plants, water, and animals. Intra-action during placemaking creates an embodied personal and a shared space between humans and non-humans (Barad, 2007). Intra-action proposes questions of co-authorship during placemaking. The flow and soundscape of the natural environment play a role and are documented in the video. The rhythm, movement, and silence are co-created with entities in the natural environment.

Vera (2021) proposes land-based design approaches to un-design the colonial space in the university context. Vera acknowledges herself and the land in diverse worlds, where different ways of being and knowing can build community and transform realities into possibilities of change. Vera (2021) presents a design process that dismantles colonial structures and separates individual and universal structures; understanding place-specific history and the natural

environment enabled us, the participants, to feel a connection to the land. Vera (2021) points out that decolonising ourselves gives us a respectful way of looking at a world where many worlds can fit. Similarly, creative placemaking can bring the idea of pluriverse and place-specific knowledge into a dialogue and enable us to know things new and have the possibility of transformation.

In this context, it is essential to acknowledge how the intersection of whiteness and placemaking is intertwined with the social constructions of race and identity. It is necessary not to overlook the implications of race, especially whiteness, and how this shapes our visual communication, experiences, and practices. Visual communication can contribute to power dynamics; awareness of and dismantling these dynamics is essential (Thompson, 2017).

Fari (2023) studied site-orientated performance while documenting how the body can be both in front of and behind the camera while trying to create a deep awareness of the place. While Fari (2023) investigates the narrative agency of the camera, Miettinen investigates the agency of the place where she is performing (Björn and Miettinen, 2024). Fari's (2023) artistic practice is similar to the first author's and highlights the challenge of providing and understanding the agency of all participating in both performing and visual communication. Placemaking can enable a platform of co-authorship and communication, but more study needs to be done to develop the agency of MTHs and the means for their communication. The practice itself enables a strong linkage and rooting with the natural environment, and the affordances it offers open opportunities for this agency and visual communication.

4.2 Bioart and performance

The finding regarding the biotextile is that this form of bioart-making can be understood as a performance by the sunflower seedlings, which later transformed into a wool tapestry of dried roots. As Härkönen et al. (2023) posit, it is necessary to identify the entity to which mandatory copyright criteria are applied. The performance of the roots stitching entitles the Sunflower Seedlings to be the performers of the stitching process. Hence, they have authorship and control as long as the performances last, as explained by Härkönen et al. (2023, Section 5.1, p. 107). However, the photography of these processes has implications for authorship as artworks.

The findings also revealed that it is essential to acknowledge the agency of the roots while stitching and its control of the action, hence having the authorship of the performance. The seedlings were autonomous, living MTHs, partly independent of human input, although only temporarily. In addition, the agency revealed by the seedlings to grow through layers of paper, and then, a woolbed revealed that their growth was sometimes beyond the control of the artist-researcher. Regarding bioart, Kac (2021, p. 1367) reminds us that 'art that manipulates or creates life must be pursued with great care, with acknowledgement of the complex issues it raises and, above all, with a commitment to respect, nurture, and love the life created'. The question of nurturing is vital in this case, as the role of the artist-researcher was nurturing, enabling the seedlings to be in control and having authorship of the process and performance. The sunflower seedlings had agency, but as Ingold (2007, p. 1) posits, they were also 'caught up in these currents of the lifeworld… not fixed attributes of matter but are processual and relational', which is reflected in the transformative process of the biotextile. From having authorship through performative growth to co-authorship in the dead state of the root and wool tapestry, the performance of the biotextile was methodical and contextual. This outcome contrasts with additional biotextiles that transformed differently into new performative growth and ongoing (slow) live processes of rot and decay.

5 Discussion

A critical framework emerged from the studies based on applied learning, self-reflection, and rational discourse stimulated by visual communication through filmmaking and photography. Our framework addresses active collaboration between humans and MTHs and how humans can deterritorialise representations through visual communication. Visual communication facilitates the use of the senses by both the authors and the audience. Filmmaking can follow the movement of MTHs and enables, for example, the use of audio, which gives room to the sounds of nature and demonstrates its independence from human impact. The sounds of wind and water are important soundscapes and independent authors in placemaking. We present the following framework:

5.1 Placemaking

Our performances with nature in various southern and northern environments relied on improvisation and intuition to explore and better understand the affordances of nature, enabling co-authorship with it. Wilmot (2020) discusses documentary filmmaking as a placemaking practice, arguing that it can be used to examine the relationships between place, a sense of belonging, the notions of home, and away, and the conditions of modernity and post-colonialism. Filmmaking was part of the placemaking performance to communicate better the authorship of nature and sensory levels of placemaking. The reflection that filmmaking creates when used with placemaking enables new ways of creating knowledge, such as new ways of knowing and understanding the authorship of nature.

Another insight into placemaking is presented by Lilja (2022, p. 206). who posits that 'movement as such produces place'. The slow meshworking of the MTH growth movements of the sunflower seedlings was placemaking in the Bioartex Laboratory at the University of Lapland. Similarly, studies of seedlings were conducted in South Australia and Japan, where they also engaged in placemaking. The movement of seedlings reacting to being and growing within one another's environment, captured by time-lapse photography as a documentation tool, illustrates their placemaking. The co-performance created during the photographic documentation (Holm, 2008) between the seedlings, as research participants, and the artist-researcher added another dimension to the placemaking activities in the laboratory and elsewhere.

5.2 Material vs. materiality

Ingold (2007, p. 1) critically investigates the term 'materiality'. He explains that it refers to 'the stuff things are made of' and 'the stuff we want to understand'. Exemplified by the biotextile (or root tapestry), the Finnish lambswool and the roots (living or dead) are the

materialities resulting from our co-authorship with MTHs. In the example of the enigma performance, the materials are the textile wrapped around and holding the heavy birch wood on the soft, light snow in northern Finland. The weight and texture of the natural materials, and their environment, resisted movement and placemaking. Visually, the resistance the materials caused to the performance was not evident at first, yet the video documentation visually communicated the difficulty of the performance and the symbolic flagellation of hauling the heavy bundle of wood through the snow.

Ingold (2012, p. 438; cf. Deleuze and Guattari, 1987, p. 454) explains materiality as the connection to consciousness. As artist-researchers, the authors investigated their practice in the context of performative ontology. Being immersed in the practice and doing the artistic practice that was corporeal and sensory enabled both authors to develop a methodology where the MTHs participated, documenting these processes and then developing artistic outcomes that could be visually communicated to the audience. The concept of intra-action (Barad, 2007) was exploited and worked to offer new information on artistic practice and visual communication about and with MTHs. Intra-action enables the co-creation and co-authorship between humans and MTHs during placemaking. Barad (2007, p. 392) emphasises the importance of responsibility and accountability in ethical relationships with others. This principle extends to artistic practice, requiring responsibility and humility in intra-actions between humans and MTHs, particularly when engaging with Indigenous places that demand respect—whether it be Sápmi or other vulnerable locations. Such respect cannot be overlooked or forgotten.

Barad (2017, p. 106) argues through their notion of spacetimemattering that entanglements are shaped by historical, political, and ethical dimensions. Entanglements signify the fundamental interconnectedness and co-composition of all matter and meaning, challenging traditional separations between objects, subjects, and their spatiotemporal dimensions. The biotextile created by the seedlings is a metaphor for how conditions required by MTHs and humans are entangled. The entanglements of the biotextile connected diverse spaces, times, and materialities into a co-authored expression, while digital expressions, also co-created with MTHs, facilitated the visual communications of such entanglements.

5.3 Digital technologies

Digital technologies enabled the documentation, digital inscription, and material understanding of the performances by (the study Roots Stitching) and with (the study video "Placemaking Through Performance") the natural environment. The documentation of the performances by MTHs and humans captured by the digital video and photographs, and the performative aspects involved in capturing and creating video and photograph, were placemaking, produced by the movement that creates a place, as Lilja (2022) explains. In the example of the biotextile, digital technologies created material understanding through the digital tracing around the temporal root activity, thereby capturing the performance in a format that can contribute to the sedimentation of knowledge, as it will be laid down in layers of documentation and investigation into the future.

As efficient pedagogical tools, digital technologies can enable critical thinking by identifying and cultivating critical thinking and enhancing the continuous flow of information and knowledge (Mhlongo et al., 2023). Visual and digital documentation outcomes, such as photographs and videos, should be critically considered through careful connection to history and context, or text and context (Sontag, 2018, 175). This article presents examples of how visual documentation and images can be dealt with in research. For example, Study 1 used text captured through a focus group discussion to create more profound insights into the contexts of the images through textual data from the 57-min focus group. Study 2, in contrast, used systematic photo and video documentation over an extended 12-week period, including time-lapse photography, to capture the history of the seedlings' sprouting, growth, movements, and stitching of the wool, including rotting and/or death, which were interpreted as performances due to the characteristics of their movements, which were stimulated by their direct environment.

The use of digital technologies, therefore, can visualise and communicate the boundaries we must critically reflect on as humans, as well as the reflective and learning capacities we need to nurture to enable effective interactions with MTHs. According to Giaccardi and Redström (2020), design processes are no longer isolated from production; instead, development and deployment are fully integrated. Technologies actively 'learn' during consumption, constantly evolving, adapting, and transforming in the process.

Thompson (2017) provides another perspective by describing the ontological turn in the context of sound studies. She examines how sound can be understood through the nature of being and existence, not only through representation. Sound can be a medium of communication and an aspect of social and cultural reality. Similarly, digital technologies are used for visual communication and to shape social relations, identities, and power structures. This question should be investigated and scrutinised from a decolonial perspective (Thompson, 2017).

5.4 Improvisation as a respectful practice

Improvisation as such is wayfinding (Ingold, 2004), which refers to making the best of and coping with the affordances of a given environment (Sarantou and Miettinen, 2017). With a sensitive and respectful attitude towards walking as wayfinding (Instone, 2015), the affordances within nature and natural environments may be better recognised for their fragility and limitations. Lilja (2022, pp. 201–204) emphasises the enactment of attentive walking to critically reflect on our extractive mindsets, juxtaposed with our human proximity to and interconnectedness with 'mineralness' as a part of the natural constitution of our bodies. At the same time, mineralness signals an additional dimension with the interconnection of mineral matter through digital technologies. Lilja (2022) explains that due to humans' contribution to substantial material devastation and heavy resource use, 'mineralness can be understood as an attribute to help us [re]think the mineral beyond the subject/object divide… but also its nature culture entanglement as the mineral constitution of bodies, including the human' (pp. 102–104). Through improvisatory practices, often born from a lack of resources and driven by thriftiness, as observed through craft-design practices in Namibia (Sarantou, 2014), our attentiveness to nature–culture affordances can remind us of our critical examination of our human boundaries and the limitations of our natural resources. Our awareness of our mineralness and

interconnectedness should stimulate humans' awareness of more respectful wayfaring with MTHs, including digital technologies.

6 Conclusion

Underpinned by ABR and comparative analysis, this article has presented two artistic studies, 'filming placemaking through performance' and 'roots stitching', to develop a critical framework based on applied learning, self-reflection, and rational discourse. The critical framework aims to enhance practices for visually communicating with and through MTHs. The studies showcase the digital documentation of performance with and by nature. One study illustrates the interaction between MTHs and humans, while the second focuses on MTH performance through a biotextile. Issues of authorship and visual communication are explored, and a framework is proposed that identifies the elements of placemaking and the roles of material, digital technologies, and respectful improvisatory practices. The visual communication of placemaking and the places gains authorship through the flow of the ecosystem: moving water, sounds of water, and wind. However, as Carbonell (2022) reminds us, we need a close attunement to MTHs to challenge our exceptionalism in natural environments. More prominently, this article concludes that the critical framework for visual communication by and with MTHs enables humans to see, grasp., and make sense of that which is less obvious—that which our consumer and other habits territorialise—and that which we urgently need to understand through reflective practices, assisted by performance partners such as MTHs and digital technologies.

Data availability statement

The datasets presented in this article are not readily available because photographic copyright. Requests to access the datasets should be directed to sarantou@design.kyushu-u.ac.jp.

Ethics statement

The studies involving humans were approved by University of Lapland Research Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SM: Conceptualization, Formal analysis, Funding acquisition, Writing – original draft, Writing – review & editing. MS: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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