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ARTICLE

Creative geographies in the age of AI: Co-creative spatiality and the emerging techno-material relations between artists and artificial intelligence

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Abstract

Artificial intelligence (AI) expands the more-than-human perspective on creativity and creative geographies, as new techno-material relations and spatialities are formed when humans and AI create together. In this paper, we suggest the concept of 'co-creative spatiality' to refer to the special sites, relations and processes of human–AI collaboration in artistic creative practice. Our study builds on interviews with 26 Finland-based artists who have used AI in their artistic work. In our analysis, we focus on the questions of what, how, where, who and with of creativity, through which we study the spatialities of creativity and their links to AI. We discuss, how the emerging techno-materialities of AI affect co-creative spatiality by stretching the boundaries of (human) imagination and sparking creativity across new imaginative terrains. Co-creative spatiality reveals novel and unfamiliar collaborations that constitute our material worlds and, therefore, we believe it invites geographical analysis from all those interested in the transformations of creative and artistic practices in the age of AI.

KEYWORDS
artificial intelligence, artists, co-creativity, creative geographies, Finland, interviews

1 | INTRODUCTION

Creativity has been a popular subject matter in geography for a long time, including a special subfield of 'creative geographies' that focuses on the cultural and artistic forms of creativity and creative practices (e.g., Hawkins, 2014, 2017a, 2019; Lundman, 2018; Madge, 2014; Marston & de Leeuw, 2013; Nordström, 2018). A new, more-than-human perspective on creativity is gained when computational creative technologies, such as artificial intelligence (AI), are brought into the discussions. The recent releases of the AI-based natural language model ChatGPT and the deep learning text-to-image models DALL-E and DALL-E 2 (https://openai.com), for example, have intrigued wider audiences and raised interest regarding creativity and AI. The topic is geographical, because, as we argue, new spatialities are formed when humans and AI create together. Creative geographers have already challenged the human-centred approach to creativity and redirected their work to material relations, mediums and dispersed agencies (e.g., Hawkins, 2021; Lapworth, 2015;

Pigott, 2020; Williams, 2016). However, techno-material perspectives on creativity have been less investigated within creative geographies (except for: Nordström, 2017; Rose, 2016; Woodward et al., 2015; Zebracki & Luger, 2019). We claim that AI expands the understandings of creativity due to its partly autonomous capacity to create novel outcomes together with humans (Davis, 2021; Feldman, 2017; Kantosalo & Toivonen, 2016). We ask what role AI plays in such creativity, what its spatial manifestations are, and what directions creative geographies can take in the age of AI.

Our paper provides an empirical exploration of the concept and processes of creativity as defined by artists working with AI. For this article, we interviewed 26 Finland-based artists who have used methods based on AI in their artistic work. The artists represent various art forms, and they have applied AI to produce different creative outputs, such as videos, paintings, interactive art installations, sound art and theatre performances. By AI, we mean the practical definition of the term as AI-based computer systems and the field in computer sciences that aims to build intelligent entities (Russell & Norvig, 1995) or creative agencies (du Sautoy, 2019; Forbes, 2020; Miller, 2019). We make a new research contribution because AI's role in artists' creative processes has not been studied in creative geographies this extensively (however, see Birtchnell & Elliott, 2018; Wingström et al., 2022). We are aware of the critique that creativity should not be understood solely as the property of artists and other creative workers (Edensor & Millington, 2018), but as our study demonstrates, artists can understand the concept of creativity in multiple ways and beyond their own artistic endeavours.

Theoretically, we contribute to creative geographies by considering the spatialities of creativity (e.g. de Dios & Kong, 2020; Hawkins, 2014, 2017a, 2019) and, especially, the techno-material relations that AI brings about when applied in artists' creative processes. We understand the spatialities of creativity mainly in a relational manner as interrelations and processes, in which techno-materialities are always interlinked with social relations (cf. Massey, 2005) and imaginations (Hawkins, 2020). Together, these relations take place in the world and can alter it (Hawkins, 2017b). Regarding techno-materiality, we refer to the computational medium of AI and how the artists work with it and simultaneously engage with their surroundings and everyday spaces. Here, 'social' refers to the ways the artists act and interact in various collaborative processes, and 'imagination' concerns the cognitive and conceptual spatialities that working with AI expands (cf. Boden, 2004).

In the following sections, we first briefly review some geographical and spatial conceptualisations of creativity. These conceptualisations are not fixed but include multiple meanings (see Hawkins, 2017a). Our special interest lies in the current streams within creative geographies that focus on the potentiality of creativity for changing worlds (Hawkins, 2017a; Nordström, 2018) and on the mediums and material relations as part of creative processes (Hawkins, 2021; Lapworth, 2015; Miller, 2017; Pigott, 2020; Williams, 2016). To study the techno-material sides of creativity, we look at the field known as computational creativity, which refers to producing creative outcomes computationally (Colton & Wiggins, 2012), and its investigations of human–computer co-creativity that we bring as a new concept to creative geographies. In co-creativity, humans and AI collaborate and affect each other's creative processes (Davis, 2021; Feldman, 2017). We discuss how computational creativity can be approached spatially and what its linkages to creative geographies could be.

Our empirical study is divided into five parts, each of which focuses on the artists' views on creativity and how they describe their creative process with AI. The analytical framework has been created based on qualitative empirical material and analysis. We focus on the *what*, *how*, *where*, *who* and *with* of creativity, with an aim to study how different spatialities and techno-materialities are manifested in these topics. In doing so, we discuss how artists understand creativity as a way of being, doing and interacting in and with the world and AI's meaning and potential in such creativity. As empirical results, we demonstrate how artists' definitions of creativity with AI imply an openness to the world and how AI influences artists' creative processes by offering them new methods, ideas and solutions. Social and digital environments are important sites of creativity for the interviewed artists, and technology and AI represent the original sources of creativity for many. However, AI's role in the creative process varies, and we make an analytic distinction between a human-centred, a context-based, a more-than-human and a co-creative approach to creativity. Also, the techno-material relations that emerge between artists and AI are multiple, which is best demonstrated in the ways the interviewed artists saw AI either as a tool, a medium or a partner.

Based on these findings, we put forward the concept of *co-creative spatiality* to demonstrate the specific, contextualised spatiality that is formed when artists and AI collaborate. Co-creative spatiality can be found in the sites, relations and processes of collaboration, and it is situated both at and beyond a human–AI interface. We discuss how the techno-materialities of AI affect and are part of this spatiality in two ways, which are stretching the boundaries of (human) imagination and sparking creativity to new imaginative terrains. We highlight the relationality of co-creativity spatiality, which is constituted by the coming-together of various spatial and temporal trajectories (Massey, 2005) and frictions (Rose, 2016). The idea of co-creativity is a useful approach to study the new spatialities and techno-materialities that creativity with AI brings along.

2 | GEOGRAPHY AND THE SPATIALITIES OF CREATIVITY

2.1 | Conceptualising creativity in geography

Creativity is a complex concept and contextualised definitions of it are necessary (Hawkins, 2019, p. 971). In general, creativity is often defined as an individual's ability or capacity to produce new, surprising and valuable things (cf. Amabile, 1983; Boden, 2010). In this paper, we approach the concept spatially from relational (Massey, 2005) and processual perspectives (Williams, 2016), meaning that our interest lies in the sites, interrelations and potentialities of creativity as they unfold in the creative processes of artists working with AI. In geography, creativity is a popular study matter and one of the 'keywords' of the field (Hawkins, 2019). Geographers have for a long time contributed to the spatialities of creativity (e.g., Crouch, 2010; de Dios & Kong, 2020; Meusburger, 2009; Törnqvist, 2011), and creative geographies in particular, and take the topic seriously by studying various themes such as art and creative products, practices and politics from a spatial perspective (Hawkins, 2014, 2017a). One of the main questions is where creativity happens. The sites and situated practices of creativity are various and, therefore, Hawkins (2017a) argues for a geography of creativity of multiple meanings. Her views on creativity include (1) creativity as a socio-spatial practice, (2) the politics of creativity and (3) creativity as a force that 'does things' in the world. In such a view, the spatial focus is on how creativity makes and (re) produces the various sites of interest, which we link to the techno-materialities of creative AI.

Geographers' interest in creativity also involves a potential for changing worlds through small bodily alterations or imagining alternative spatialities (Hawkins, 2017a; Mould, 2019; Nordström, 2018). Such creative 'doings' are often done through and with the help of various mediums (Hawkins, 2021) and are grounded in an openness of future and space that are always under construction (Massey, 2005). For example, for Madge (2018), the transformative potential in a creative process means an opportunity to liberate imagination. Nordström (2018) interprets creativity as the potential that changes the ways of seeing, whereas Mould (2019) sees potentiality in the alternative uses of objects that help create breaks in functional systems. Pigott (2020) describes creativity as 'a way of remaining intuitively open to possibilities in the present, while also developing a sensitivity to that which cannot be known, cannot be sensed' (p. 886). Introducing AI into these discussions reveals interesting paths for creative geographers because, as our analysis demonstrates, AI can extend human creativity to new and alternative spatial imaginations and, thereby, support an open approach towards the world.

The current geographical discussions about mediums and materialities provide critical thoughts about creative actors and agencies by questioning the rational human subject's role in creativity (e.g. Pigott, 2020; Williams, 2016; see also Harris, 2021). Some creative geographers focus on non-human objects (Mould, 2019) or look beyond creative human actors to material relations (Lapworth, 2015; Pigott, 2020; Williams, 2016). This has meant detaching from a human individual in control of the creative process, depicting both more-than-human and posthuman approaches to creativity. From a more-than-human perspective, materials and objects affect creative processes in an interaction (Miller, 2017; Watson et al., 2009; see also Bennett, 2010). In this case, the human still has a central role but beyond a Cartesian dualistic subject, as in Miller's (2017) research on artists' tangible material practices 'with clay'. The posthuman perspective moves towards the 'dispersed agencies' of humans and nonhumans and to the mutuality between them (Pigott, 2020; Williams, 2016; see also Barad, 2007). This means declaring the conditions of creativity as 'not reliant on, determined by or necessitated for an anthropomorphic domain' (Williams, 2016, p. 1555). Such an approach does not mean denying the human but rather presents human beings as incomplete and responsive to creative impulses. These relational and material perspectives of creativity gain new dimensions when one or more of the creative agencies are based on AI.

2.2 | Computational creativity and its spatialities

Although digital and computational technologies, and lately also AI, have been popular topics within geography (Ash, Anderson, et al., 2018; Ash, Kitchin, et al., 2018; Kitchin & Dodge, 2011; Lynch & Del Casino, 2020), their potential as creative agencies has often been dismissed from geographical inquiries. Here, we introduce the field of computational creativity into geography and discuss how it can be understood spatially. Computational creativity is considered a subfield of AI (e.g., Colton & Wiggins, 2012; Kantosalo, 2019). Operationally, AI includes such functions as data acquisition, interpretation and processing, and it is able to 'decide' the best actions to take to achieve the given goal. AI systems can learn and adapt their behaviour 'by analysing how the environment is affected by their previous actions' (JRC, 2020, p. 9). In arts, this means, for example, that instead of giving predefined codes and rules for an algorithmic artwork's aesthetics,

the artist sets up an AI that 'learns' from a large amount of input images and then generates new images following the aesthetics it has learned (Mazzone & Elgammal, 2019).

Colton and Wiggins (2012) define the scope of computational creativity to include '[t]he philosophy, science and engineering of computational systems which ... exhibit behaviours that unbiased observers would deem to be creative' (p. 21). Computational creativity also refers to developing computer programs that produce works of art autonomously (Davis, 2021) and to studying and conducting artistic practices that utilise methods based on creative AI (du Sautoy, 2019; Forbes, 2020; Miller, 2019). Creative AI and AI-based art can take various forms, including, for instance, visual style transformations, in which an image can be composed in the style of another image (Gatys et al., 2016), AI-generated images based on neural networks and large datasets (Hertzmann, 2020), music and sounds conducted through generative models (Dhariwal et al., 2020), automatically generated poems and other texts (Kantosalo, 2019), and various kinds of interactive art installations (Lugrin et al., 2006; see more examples at www.aiartists.org and www.aiartonline.com).

One approach in computational creativity is so-called human–computer co-creativity (e.g., Davis, 2021; Feldman, 2017), with an aim to 'facilitate human creativity via computationally creative means and vice versa' (Kantosalo, 2019, p. 1). Whereas earlier computational agents were mostly seen as tools, in recent studies, creative AI has been considered more of a medium or partner to humans (Davis, 2021; Elgammal & Mazzone, 2020; Kantosalo & Toivonen, 2016). This is also the case with art-generating AI algorithms that, according to Mazzone and Elgammal (2019), are closer to a medium than just inanimate objects or tools that artists use. They remark that 'the paintbrush does not have the capacity to change, it does not make decisions based on past painting experiences, and it is not trained to learn from data. Algorithms contain all of those possibilities' (Mazzone & Elgammal, 2019, p. 8). Kantosalo and Toivonen (2016) take the idea further and describe humans and computers as co-creative partners that take turns or have specific roles in a creative process. Interaction and iteration are important in such human–computer partnerships.

Spatially, computational creativity can be linked with the socio-material relations between humans, machines and their surroundings or, more precisely, between people, products, processes and places (modified from Jordanous, 2016). As Jordanous (2016) writes, computational creativity 'cannot exist in a vacuum' (p. 200) but AI systems are intertwined with social environments and social creativity. Co-creativity between humans and AI often happens at an interface or on other similar platforms that are spatial by nature. Geographer Gillian Rose (2016) describes the interface as 'the mutual constitution of human practice, digital hardware and software code' (p. 341). In such a view, interfaces are not enclosed objects but relational systems (Ash, Anderson, et al., 2018), which is also how we approach co-creativity between humans and AI.

The spatiality of computational creativity manifests also in the ways in which creativity takes place and new ideas arise together with AI. Margaret Boden (1998, 2010) has made a division between the combinatorial, exploratory and transformational forms of creativity, which she links to creative AI. She writes, 'AI techniques can be used to create new ideas in three ways: by producing novel combinations of familiar ideas; by exploring the potential of conceptual spaces; and by making transformations that enable the generation of previously impossible ideas' (Boden, 1998, p. 347). Through co-creativity, existing or imaginary boundaries regarding creative thinking and action can be crossed, which relates to the idea of transformative creativity as a potentiality for liberating imagination (in creative geographies, see Madge, 2018). Moreover, the notions of AI having its own creative agency (Colton & Wiggins, 2012; Davis, 2021) or being a partner to humans (Kantosalo & Toivonen, 2016) resonate with geographers' recent discussions on the more-than-human and posthuman understandings of creativity (Miller, 2017; Pigott, 2020; Williams, 2016). This becomes evident in how AI has a unique creative capacity of its own, as it can learn and create new and surprising results (Boden, 1998, 2010) and how, at the same time, the agencies of humans and AI are entwined and evolve together in a spatial co-creative process. As in creative geographies more widely, both these views challenge the role of the human individual as the only creative actor (see Harris, 2021) but they also widen the perspective into computational, digital and virtual realms discussed in digital geographies (Ash, Kitchin, et al., 2018; Kinsley, 2014; Kitchin & Dodge, 2011; Rose, 2016; Woodward et al., 2015).

One important aspect regarding the spatialities of computational creativity that, however, is outside the scope of this paper, is the ethical dimension of AI. The ethics of AI is a widely discussed topic (e.g., Crawford, 2021; Jobin et al., 2019; Russell et al., 2015), and geographers, too, have a lot to contribute to the spatial issues regarding the political, societal and moral sides of AI and algorithmic power (see Amoore, 2020; Gieseking, 2019; Kitchin, 2017). This also has implications for creative AI, including such things as socially biased and discriminatory datasets (de Vries, 2020) or applying the outcomes of visual AI to produce misinformation in geospatial visualisations (Zhao et al., 2021). We see that artists have the ability and power to bring up and explore these ethical challenges, shortcomings and threats of AI, for example, when it comes to the misuses of datasets, surveillance and any form of algorithmic power (see Stark & Crawford, 2019). Therefore, it is important to gain a better understanding of what the artists using AI think about these issues and AI's role in their creative processes.

3 | DATA AND METHODS

To gain a detailed and more context-specific (Hawkins, 2017a; Williams, 2016) understanding of creativity and AI, we interviewed 26 Finland-based artists who use or have used AI-based methods in their artworks. Half of the interviewees work as full-time professional artists, and the rest have varied roles in the fields of artistic research, art education and/or ICT-related jobs. Most interviewees have a formal art education, and some have a background in coding, engineering and other similar fields. A third of the informants work in established multidisciplinary art collectives or partnerships. Other artists use changing collaborations or external experts in their AI-powered works, and even those working more individually described some level of connection with other artists and/or ICT people, often in various online communities or on social media.

The interviewed artists represent various art forms. Most of them can be described as new media artists, with a focus on digital media, but there were also representatives from visual arts, electronic music and performing arts. None of them identified as purely AI artists, and some found the concept too narrow or defining (e.g., A5, A10). The artworks in which the artists have used AI include, for example, interactive art installations, paintings, prints, videos, theatre and music pieces, and the AI methods employed include, among other things, generative adversarial networks (GANs), machine vision, and text- and music-generating neural networks. Some of the artists used ready-made AI programs and functions, but most rewrote, adjusted or made the codes and parameters themselves or in collaboration with ICT professionals. We do not provide more detailed descriptions of the art forms, artworks or methods to safeguard the interviewees' anonymity. The artists are identified in the text using the pseudonyms A1–A26.

We conducted the interviews during the spring and early summer of 2020. The artists were found through an internet search, artist databases and snowball sampling. The number of Finland-based artists who have presented AI-based artworks in public is small, so they were relatively easy to find, and all participated in the interviews voluntarily. All but three interviews were conducted online via video conferencing. The interviews were semi-structured, meaning we covered specific themes, but the conversation remained relatively open. We asked the informants to define the concept of creativity and describe their creative processes in detail. Issues pertaining to AI, art and creativity were elaborated from various perspectives. We focused on how artists described their work together with AI and whether they felt that AI had any creativity of its own. Moreover, we discussed the term 'co-creativity' with the interviewees and learned how they received the concept.

We created the analytical framework for our study based on the empirical material and a three-phase analysis. First, we conducted a qualitative content analysis (Hsieh & Shannon, 2005) for all definitions of creativity and AI's role in it in the interview material. We did this by organising and identifying themes with the help of interview questions and the analytic codes derived from them. The aim of our content analysis was to study the meanings the interviewed artists gave to creativity in a particular context (Krippendorff, 2004), which in this case meant their creative process with AI. Second, we analysed our interview data by using descriptive codes (Cope, 2010) of the *what*, *how*, *where*, *who* and *with* of creativity, with which we were able to find what we consider the spatialities of creativity and their links to AI. Similarly to Hawkins (2017a), we see that the geography of creativity includes multiple meanings, and the variety of our descriptive codes helped us approach the topic from different perspectives. Third, we developed the analysis further by reflecting on the definitions of creativity and finding connections between them and AI's role in the artists' creative processes. Next, we demonstrate our analysis and findings by giving the primary space and voice to the artists' own notions about creativity and AI.

4 | ARTISTS, CREATIVITY AND ARTIFICIAL INTELLIGENCE

4.1 | What is creativity?

Interviewer 1: How would you define creativity?
A15: It's really context-related; it's redefined always on a case-by-case basis … It's like art … never fixed to anything.

This comment from one of the artists, A15, relates to the need to define what creativity means in different contexts (Hawkins, 2017a; Williams, 2016). In spatial terms, we have analysed what meanings the interviewed artists give to creativity regarding their relation to the world and how AI may affect it. Many artists saw creativity as 'inherent in life' (see Crouch, 2009; Hallam & Ingold, 2007) or, as we have categorised the answers, *inherent in life across space and time*.

This pervasiveness of creativity became evident, for instance, when A8 responded: 'Creativity is an ability belonging to everyone'. Moreover, the artists defined creativity as an ability to imagine (A24) or, in terms of artistic practice, to re-think action and tools from a new perspective (A23). These notions demonstrate a preparedness that things can be otherwise and the unpredictable nature of the unknown future. AI did not play a strong role in these general definitions of creativity that the artists provided.

Creativity can also be understood as the capacity to reassemble and reconsider the artistic processes of working differently. Many artists spoke about how, in artistic work, creativity is the power from which to take off (A2), the freedom to break norms (A24) or the possibility and courage to combine things in unusual ways (A8). For A3, creativity was about the 'courage to grab onto the moment and to try things that seem impossible'. Such dynamic ideas of creativity resemble what some geographers call processual (Williams, 2016) and subversive forms of creativity (Mould, 2019). In such cases, creativity is understood as an emergent potential that makes it possible for existing societal orders to be questioned (Mould, 2019). These examples of creativity represent what we call creativity's *potential for differentiation* (see Deleuze, 1994/1968), involving the world full of opportunities as well as a more active courage and willingness to do things differently. AI's unpredictability, which was described by many artists (e.g., A2, A3, A12), involves a capacity to extend such creativity into new spatial imaginations.

As most comments made by the artists above relate creativity mainly to human life, introducing computational creativity and AI to such a conceptualisation can be difficult. Clearly, it would be too much to say that creative AI alone is inherent in life. It is more relevant to think about how AI affects human creativity and how it expands the *limits* of creativity, which relates it to spatial thinking (cf. Daniels, 2011; Gregory, 1994). Although many artists have a very practical view on AI, several answers indicated that AI brings new aspects to human creativity. A5 expressed how new technologies lead to areas that cannot be accessed by other means. The artists saw that AI has an ability to produce images and text beyond human imagination (A3) and to generate sounds that one cannot imagine otherwise (A25). A21 said that neural networks 'create their own world that is true and untrue at the same time'. Hence, creative AI involves the potential for differentiation because it is able to create unknown digital and material realms that humans can explore. The artists' answers show that AI has the capacity to stretch creativity to new domains and engage people in exploring unfamiliar terrains (see also Williams, 2016). Spatially, this means supporting an open and responsive orientation towards the world and offering new opportunities for (human) creativity.

4.2 | How does creativity happen in the world?

> ***A15***: [Creativity] is associated with intuition and this kind of uncontrollable flowing. Or it's a feeling that you are doing, that one really creates ... There's a game of chance, and chance has a lot of space there ...

In some of the artists' answers, as in the one quoted above, creativity is as much about chances and experiments as it is about directed and practical action. In spatial terms, creativity – and particularly creativity in arts – is a process where these different elements intersect simultaneously as *incidental*, *experimental* and *directional* worlds. For the artists, incidental worlds included uncontrollable things, flow, intuition, chance and errors (A15), fragmented nowadays (A4) and non-intelligence (A10). Experimental worlds were related to activities such as trying (A3), freely associating (A15), combining unlikely things (A24) or fooling around (A10). A3 described creativity as 'a playful approach to everything'. The directional worlds involved work and effort (A2, A15) as well as limits in terms of space and time. A1 stated how 'creativity happens within borders'. These reflections on creativity resonate with Miller's (2017) idea that creativity includes improvisation, skilful practice and conscious activity. All these different worlds (incidental, experimental and directional) were also recognisable when the artists described their creative process together with AI, indicating that a human–AI relation involves and requires both improvisation and play but also skilfulness and work.

As an active state and practice, creativity strives to do something that has not existed before. In many answers, we see an orientation towards what we call *creativity as changing worlds*, which is close to Hawkins's (2017a) idea of creativity being a force that does and makes things happen. This includes both the personal and shared worlds being altered in different ways. A7 described creativity as seeing, thinking and creating possibilities, 'a kind of openness of thought'. For the artists, creativity was as much about a feeling of novelty (A11) as it was about making or creating new things (A13, A26), to produce anything at all (A17) or to carry out something (A26). For many, AI strengthened these personal processes by offering new methods or ideas. According to the artists, creativity was also related to finding and solving problems (A15, A16), to questioning existing orders (A24) and to coming up with new ways to act. Therefore, it is

important for societies in the pursuit of change (A5). AI and its creative potential were seen both as a societal opportunity and threat. These examples demonstrate a dynamic view on creativity and creative processes also when they take place with AI.

When exploring the role of AI in the artists' actual creative practices, we enter new possibilities for creativity to happen. Here, Boden's (1998, 2010) ideas on combinational, exploratory and transformational forms of creativity are useful. When the artists spoke about how AI offers novel ways to think of or make art, some of their thoughts were close to Boden's concept of combinatorial creativity. A12, for instance, saw that 'with different combinations you can get surprising results that you wouldn't reach otherwise'. Boden's exploratory notions of creativity were recognised when A17 said that AI produces 'interesting new variations'. A slightly similar point was made by A7, who stated that AI opens up 'new routes, opportunities, and methods'. Some artists described their explorations with AI as jamming (A6), playing (A16, A22, A25) and experimenting (e.g. A1, A3, A19). Boden's transformational creativity is similar to creativity as changing worlds. A21, for example, explained how getting to know the possibilities of AI fundamentally altered their approach towards doing artistic work. On a personal level, this relates to Madge's (2018) thoughts about liberating imagination and Nordström's (2018) idea of changing the ways of multisensory seeing. On a societal level, several artists mentioned how combining art and creative AI can bring benefits both to the development of technology and to societies in general because artists can focus on critical and ethical questions (cf. Stark & Crawford, 2019). As A15 said: 'I think it's important that art makes use of these new tools. It's an artist's responsibility'. However, some artists were worried about what AI will do to art and creativity in general. As A4 expressed it: 'Will creativity only become a push on a button?'

4.3 | Where or from what does creativity originate?

> ***A7***: Perhaps it requires emptiness first ... and then ... there needs to be some idea or association that you need to take forward because they interest you so much.
> ***A2***: At best it is when you start a programme and some interesting material comes out, and then you can get excited about it ... It's kind of co-creativity.

Many of the artists' answers explore the basic spatial question of where or from what creativity originates and what affects it. The artists talked relatively little about the effects of the physical environments on their creativity and creative processes. Instead, social and digital environments were among the key sites of creativity for many. International visits, residences, workshops and university courses were mentioned as important social milieus where many interviewees had gained an impulse to create art with AI (e.g., A9, A15, A24). Other special environments involved online AI platforms, social media and open-data repositories and libraries, indicating that coding is a collaborative practice that can take place regardless of physical distance (see Lima et al., 2014; critically, see e.g. Zook & Graham, 2018). This supports the idea that interfaces and other digital platforms are relational systems that both humans and technology are part of (Ash, Anderson, et al., 2018; Rose, 2016).

Several artists had a very *mundane* understanding of creativity, such as when A1 described that 'the most part of creativity happens in everyday life'. Creative moments can take place while walking on the street (A1) or reading the newspaper (A3). Everyday life as a source of creativity is recognised also by geographers such as Edensor and Millington (2018), who state that creativity flourishes in quotidian spaces pertaining to various mundane domestic, work and/or leisure practices. Some artists answered that creativity is born as a compulsion or from an inner need. For instance, A24 depicted how their creative process 'starts from something spontaneous ... that you are attracted to something or amazed by something, that you get this obsessive urge to do something about it'. In these quotidian or deeply personal views, the role of AI as an active source of creativity was not clear but could still be seen as a catalyst for creative thinking and action.

Some artists found the source of creativity more specifically *in relations*. This brings their creative process close to the relational understanding of space (Massey, 2005). A22 paid attention to shared human work: 'It's through our discussions that it emerges organically, where someone has the initial idea that is then processed in the group'. However, it is not only a human domain that fosters and evaluates creativity; it happens also in socio-material environments (Watson et al., 2009) or, as we claim, in techno-material relations. A6 marked how previous events, encounters and environments can affect how creativity is born: 'It originates from what has happened before, how we are in the world with others'. This depicts a processual understanding of creativity, where creativity originates from the coming together of those who are present at a moment and their affective encounters and mobilities along the lifepaths (Nordström, 2018; see

Massumi, 2015). As an autonomous creative agency (Davis, 2021) and a co-creative partner to humans (Kantosalo & Toivonen, 2016), AI can be part of such processes and encounters both now and in the future.

For many artists, a special source of creativity includes the mediums or materials they work with (Lapworth, 2015; Miller, 2017; see also Hawkins, 2021), which in this case is creative AI. Many artists spoke about how technology and AI had been a starting point for their work and how it had inspired them. For example, A25 considered that 'AI moves my creative process forward and ... it lets me look at things from a different perspective. It brings me something that I wouldn't even think about'. As a medium, AI includes several elements of surprise and unpredictability (see Boden, 1998, 2010). Several artists were interested in the errors, mistakes and roughness of the current AI systems, and many of them had incorporated these mistakes into their work. For instance, A4 explained how they had purposefully looked for the errors in the AI-generated material and began to direct their creative process in that direction. This kind of creative misuse of technology can create ruptures in ordinal practices (cf. Mould, 2019). It also indicates the potential of AI to participate in artistic processes. Central to the artists' view was to see creativity stemming in and from the relations between humans and technology. However, some artists (A2, A8) had become frustrated with AI and returned to the more traditional forms of art such as drawing or painting by hand. Hence, the relation between an artist and their medium is not always static or straightforward.

4.4 | Who or what is creative?

> ***A1***: I don't think AI is creative when it roams around ... but there's the wholeness it moves towards that I can see. So it's the collaboration that is creative.

With the question of who or what is creative, we move further towards the emerging techno-material relations regarding creativity and AI. Creative actors or agencies, which can be both humans and/or nonhumans, are an important part of creative processes also recognised by creative geographers (e.g., Mould, 2019; Pigott, 2020; Williams, 2016). With respect to human creativity, both individual and collective perspectives stood out in the artists' answers. Several artists saw creativity as an important part of their work (e.g., A15, A27) but also criticised the myth around the artist as a creative genius (A4, A15, A22). Collaboration with other people was considered crucial for human creativity by many artists (e.g., A2, A6, A11), but creative collaboration could also take place between humans and nonhumans (A5).

AI systems including at least some level of autonomy challenge the idea of who or what is creative (Colton & Wiggins, 2012; du Sautoy, 2019; Forbes, 2020; Miller, 2019). When we asked the artists whether they think AI is creative or not, the answers were diverse and distributed. Those who answered in the negative argued, for example, that it is the human making or using AI who is being creative and not technology, because AI is only code (A17), mathematics (A19) or an unintelligent tool (A26). This is specifically the case with the so-called narrow AI systems, which by definition can accomplish only a narrow set of goals, as opposed to general or strong AI that can reach far wider goals such as learning or superseding human-level intelligence (Tegmark, 2017). Some artists suggested that AI may have some level of creativity in the future but said that no such general or strong AI exists yet or perhaps will ever exist. These answers present *a human-centred* approach to creativity. Some artists were also critical of the entire question of whether AI is creative or not, saying that the question is uninteresting (A1) or banal (A20).

Many artists pointed out the ambiguities and controversies around creativity in AI. Instead of answering the question of whether AI is creative directly, they described a *context-based* approach where the creativity of AI depends on how one defines the concepts. The differences among the narrow, general and strong AI demonstrate this situation well or, as A6 called it, the division between the 'sci-fi-transhumanist-utopian-dystopian' and the 'tool-oriented' perspectives. A22 claimed that AI can be creative in technical but not in artistic terms. A9 saw that although AI has no intention, neural networks can produce things that have not been planned in advance. A similar point was made by A7, who said that although lacking intentionality, generative algorithms can combine new things and produce surprises. These answers are close to Boden's (1998, 2010) ideas of creativity.

The artists who thought that AI is creative and/or has creativity pointed out the surprising and strange components of AI that, according to A4, cannot be a mere coincidence. Some artists made references to other-than-human agency (A5, A24) and claimed that creative AI should have value of its own (A22). These views represent what we call the *more-than-human* approach of creativity, where AI has its own capacity to act creatively. It corresponds to the ideas in creative geographies underlining the roles of the material agencies and objects in creative processes (Lapworth, 2015; Mould, 2019) and to the ambitious goal in the field of computational creativity aiming to realise autonomous creative

machines and AI-generated art (Colton & Wiggins, 2012; Davis, 2021). However, although some artists said that AI has a creative agency in its own right, they did not necessarily see it as equivalent to human creativity.

Several artists took up the issue that AI is creative together with humans. We see this as a continuum to more-than-human creativity, which we categorise here as a *co-creative* approach. In such a view, humans and AI collaborate and mutually affect each other's creative processes (Davis, 2021; Feldman, 2017; Kantosalo & Toivonen, 2016). For instance, A8 remarked how 'the process between AI and the person who interprets it can be very creative', and A15 stated that 'I see that it's the combination of AI and a human [that is being creative]'. This close relationship between people and their tools, materials and mediums they work with is acknowledged in creative geographies, for example, by Lapworth (2015), Miller (2017) and Williams (2016). Theoretically, we get close to posthuman thinking about dispersed agencies and the intra-relations between them (Pigott, 2020; also see Barad, 2007), where creative agencies between humans and machines are entwined in a dynamic creative process. We discuss this mutual relationship between the artists and AI in the next section.

4.5 | Creating together with AI

> ***A5***: [C]reativity is somehow a symbiotic activity ... I'm interested in AI as a means to create or do things because the artists' agency is questioned in it ... It is sharing and doing co-operation with some other agency.

Although (human) social relations were important for the artists' creativity, we found that their relationship with the nonhuman agency of AI was also deep and inspiring. The role of AI in the artists' creative process can be illustrated in the ways in which the interviewees described their work with AI and whether they comprehended it either as a *tool*, a *medium* or a *partner* (cf. Elgammal & Mazzone, 2020). Several artists mentioned that they thought AI was *only* a tool. As A20 described: 'I think it's a tool ... It will not sing, it will not make new art. It can only be used in novel ways, and any tool can be used in novel ways'. The artists drew several analogies between AI and instruments such as paintbrushes, hammers, chisels or axes; matter such as paint, clay, ink or colour; and contexts, such as factories, laboratories or artist's toolboxes. These findings support the notion that the creative workers are in a close relationship with the tools and materialities they work with (Ingold, 2013) but still see the technology as a separate entity from themselves.

For many artists, working with AI represented a more intense means or medium to achieve broader goals, making it 'more than a tool' (see also Mazzone & Elgammal, 2019). According to Hawkins (2021, p. 3), in cultural geography, the medium often refers to material-embodied practices of making and creating that can have a wider methodological value. An example of this was when A21 spoke of how 'these new perspectives offered by AI made me do totally different and various things ... It has liberated my action in many directions, because it just feels like a powerful and miraculous medium'. In this encounter between the artist and AI, artists began to see their work differently.

The collaborative and mutual nature of the relationship between the artists and AI became even more pronounced when the artists were asked about the concept of human–AI co-creativity. Many of them liked the term and recognised their way of practising together with AI in it. Some artists noted that co-creativity with AI forms a deep interaction (A4, A15, A22) and confluence (A9) between the artist and technology. In such instances, AI was seen as an equal partner to humans or, as A9 put it, 'a companion-like extension'. Some descriptions were personal, such as when A2 spoke about how co-creativity is about intuitive communication with AI or when A7 spoke of how the results produced by AI cause emotional responses in their bodies. These answers involved indications of the posthuman perspective of creativity, where social, material and technological relations form and are formed by dispersed agencies together rather than by creative humans or creative machines separately (cf. Pigott, 2020). Both human and nonhuman agencies affect each other mutually during the co-creative process. For example, A2 described that when working with AI, 'the artist does something, and then AI catches it ... and creates something new about it ... and then the artist answers to it and starts to communicate with AI'. Several artists described their work with AI as curating (e.g., A6, A21; see also Mazzone & Elgammal, 2019), where AI creates a large amount of material from the input data and then the artist chooses the most interesting parts of it to incorporate into the final artwork. This often happens iteratively and, as some artists (A3, A21) described, intuitively. Hence, the co-creative process between the artists and AI takes place in close communication and shared action between the creative human and nonhuman agencies.

Among these different relationships between the artists and AI, we claim that seeing AI as a co-creative partner to humans best represents the novel perspective on the techno-material relations that creative AI gives rise to. This was most evident when the artists illustrated the affective capacities of AI and their deeply personal interactions as part of

a human–AI interface. However, one should not understand computational creative technologies as the only means of reaching creative results in current digital times. As some artists noted, all creativity involves co-creation (A16), and tools and materials always influence the creative process (A23). Moreover, some artists said that the concept and idea of co-creativity between humans and AI are too romanticised (A12, A14). Nevertheless, the creative agency of AI includes a new potential for expanding human creativity and vice versa, which is related to the potential for differentiation and how the affective capacities between bodies (or, in this case, human and nonhuman agencies) alter in relations (see Deleuze, 1988/1970). In other words, when AI and artists support each other's roles during the co-creative process, they increase their respective capacities to create novel outputs in previously unknown ways. As A21 put it when summarising their creative process with AI, 'both of us partners are needed there; we both get something, and we both have our own ways of being creative'.

5 | CO-CREATIVE SPATIALITY IN THE SITES AND RELATIONS OF HUMAN–AI COLLABORATION

Building on the findings above and the studies of co-creativity in the field of computational creativity (Davis, 2021; Feldman, 2017; Kantosalo, 2019; Kantosalo & Toivonen, 2016), we develop our theoretical contribution to creative geographies by presenting the concept of *co-creative spatiality*, by which we mean a contextualised spatiality being created in the sites and relations, at and beyond the interface, where humans and AI collaborate in a shared creative process. To understand co-creative spatiality and AI's influence on it, we now return to our results and discuss them further from spatial and techno-material perspectives.

In general, the interviewed artists described creativity being inherent in life across space and time and having potential for differentiation. Working with AI adds a further layer to these thoughts, as it brings new techno-material relations – related to the computational medium of AI and the creative sites and everyday spaces of the artists – to the creative process. Here, co-creativity manifests as potential for change through the capacity for new spatial imaginations being created when artists and AI influence each other. Examples of this were when unexpected images and sounds were created as a result of the co-creative process and how the process and its outcomes affected artists' thinking and practices in various ways. This supports what we call openness to the world, by which we mean a world with new opportunities for transformation and change. In this way, co-creative spatiality is in line with recent conceptualisations within creative geographies focusing on creative doings and changes in the world (Hawkins, 2017a, 2017b; Madge, 2018; Mould, 2019; Nordström, 2018; Pigott, 2020), but it also enriches these discussions with its attention to techno-material relations and digital mediums.

Nevertheless, although digitality has an important role in co-creative spatiality, the artists who work with AI are neither mediated by the digital technology of AI alone (cf. Kinsley, 2014; Leszczynsky, 2015) nor merely entering an immersive spatiality of the digital (Rose, 2016); rather, the co-creative work is multi-sited and influenced by different relations. These relations involve AI but also other humans and nonhumans, sites and events. The several sources of inspiration and creativity mentioned by the artists, varying from digital environments to social milieus, demonstrate the many sites of co-creative spatiality. This means that co-creativity is not easily traceable, as it happens at the sites where AI is produced; at the interface where the creative agencies of humans and AI perform together; and in the everyday spaces and social encounters between and among the humans and the digital (see Ash, 2015; Kinsley, 2014; Leszczynsky, 2015; Rose, 2016). By extending the focus beyond the digital realm to co-creativity, we found how the work of creating art between humans and AI takes place in a complex manner in different sites and relations that constitute and are constituted by co-creative spatiality.

We have also shown that the co-creative process with AI – and, therefore, also co-creative spatiality – is not only limited to directional worlds of making an artwork at a digital interface, but it also involves incidental and experimental worlds that shape creativity and its outcomes in unexpected ways. Such creative incidents and experiments with AI involve play, flow, intuition and chance but also ruptures and errors. The incidental errors intrinsic in working with digital technologies have been previously recognised in geography, for example, by Rose et al. (2014). Rose (2016) uses the term 'friction' to describe the challenges that are encountered at interfaces of digital production. Less attention has been paid to friction as having potential to influence creativity in productive ways. As many of the interviewed artists described, making art with AI includes surprises and moments when the anticipated process does not proceed smoothly, which demonstrates the unpredictability of and frictions in co-creative spatiality.

Creative agencies, too, need to be elaborated to understand co-creative spatiality and the relation between humans and AI as they enter the creative process together. In her study about creative agency, Harris (2021) recognises that creativity resides in all environments, things, events, organisms and impulses. Our findings are in line with this more-than-human notion about creativity. When the artists talked about their creative process with AI, they described how they were working with a tool, being influenced by a medium or communicating with a partner. From a more-than-human perspective, we interpret that also nonhumans are affective and vital in the co-creative processes and relations they participate in (cf. Bennett, 2010). Co-creativity, and thus co-creative spatiality, can be also approached from a posthuman perspective as a mutual relation between humans and AI. If compared to other geographical research on creative mediums and materialities (e.g., Hawkins, 2017a, 2021; Miller, 2017; Mould, 2019), we claim that AI forms a unique creative agency due to its capacities to learn and adapt partly independently and to create something new and surprising from a given input data (see also Boden, 1998, 2010).

When the results of our study are drawn together and further conceptualised, two particularly intriguing aspects of co-creative spatiality arise with respect to emerging techno-material relations and creativity; namely, how co-creativity (a) *stretches* and (b) *sparks* imaginative terrains through human–technology collaboration. First, from the standpoint of the artists, the co-creative process with AI encompasses a capacity for change, as co-creativity stretches the boundaries of (human) creativity and imagination. This can be exemplified by the unimaginable images, sounds and texts that are being created with AI. In other words, working with AI expands the imaginative terrains that have earlier been described in the literature of geographical imaginations mostly from a human perspective (Daniels, 2011; Gregory, 1994; cf. Boden's exploratory creativity). Hawkins (2020, p. 17) has asked whether we should revisit the idea of imagination beyond its human-centrism, and here co-creative spatiality is a useful concept. Despite ontological differences, our study demonstrates that co-creative spatiality can involve both more-than-human and posthuman approaches towards the world and creativity.

Second, our study shows that co-creativity between humans and AI is also about sparking new imaginative terrains, which we see as a follow-up to the conceptualisation of friction by Rose (2016). Friction creates spark, and as the work with AI is frictional, it can lead to whole new imaginative terrains in the posthuman world (cf. Boden's transformational creativity). This takes place through communication between humans and digital technology, as when the artists iteratively and intensively collaborate with AI and curate the material that has been created. While not all the moments with AI are productive, they can become creative through the errors, mistakes and roughness that further influence the final artworks. Here, co-creative spatiality manifests as new and surprising art in the world.

To summarise what we mean by co-creativity spatiality, we must approach the concept from a relational perspective. By using relational terminology, co-creative spatiality consists of coexistent spatial and temporal trajectories (Massey, 2005, p. 9) that are as much social, material, imaginary and – especially, in the case of AI – technological and digital (cf. Ash, Kitchin, et al., 2018; Kinsley, 2014; Kitchin & Dodge, 2011; Rose, 2016; Woodward et al., 2015). As we have demonstrated in this paper, the sites and relations of co-creative spatiality are linked to the general idea of creativity that spreads across space and time; to the socio-material constellations of where the code and data is collectively produced and distributed; to the digital interfaces where hardware, software and humans create together; to the everyday moments, social milieus and materiality of technology that give impulse to artists to create with AI; and to the mutual and collaborative relationship that develops between an artist and AI during a co-creative process. At its simplest, co-creativity spatiality actualises in the moment when an artist opens the AI program, enters the human–AI interface, and 'pushes the button' to launch the creative process (which, nevertheless, was a fear articulated by one of the interviewed artists, A4). However, we claim that co-creative spatiality involves all the spatial and temporal trajectories that proceed and follow that moment (cf. Harris, 2021) and the frictions that ensue (Rose, 2016). It is in this relational co-creative spatiality where the collaboration between humans and AI can stretch the boundaries of imagination, create a spark for new imaginative terrains and create new art in the world.

6 | CONCLUSION

As computational creative technologies such as AI develop in society and enter the everyday, creative geographies should also be updated to better understand the changing spatialities of creativity that these new technologies bring about. Here, our methodological shift from the production of digital objects and spaces (Ash, 2012; Ash, Kitchin, et al., 2018; Rose, 2016) to co-creativity and co-creative processes (Davis, 2021; Feldman, 2017) takes into consideration the potentiality that lies in the unfamiliar collaborations between humans and AI. The role of a human creative agency has already

been challenged in geography, and much discussion has evolved around the processual and material understandings of creativity and creative practices. However, digital technologies and techno-material relations have been mostly left outside these ponderings, although the potential of AI as a new form of creative agency is gaining more and more attention in arts and sciences. In this paper, we have filled this gap in the research on creative geographies by interviewing 26 artists who have used AI in their artworks, and we asked them about their thoughts and experiences of creating art with AI.

The results of our study reveal multiple meanings that the artists give to creativity and AI. Through the analytical framework of the *what*, *how*, *where*, *who* and *with* of creativity, we have been able to detect the compelling spatialities and techno-material relations regarding creativity in general and creative AI in particular. For instance, the artists saw creativity as inherent in life across space and time as well as a potential for differentiation – that is, to be open to change or to do things differently in the world. In such cases, AI could help to expand the limits of human creativity. The artists described that creativity occurs in the worlds that are simultaneously incidental, experimental and directional, and the same applies when AI is part of their creative processes. Many artists saw creativity as centred on changing worlds both at the personal and societal levels, and many of them specified how AI can help with these processes. With regard to the source and sites of creativity, the artists described the importance of social and digital environments and how creativity is born in and from the everyday, inner needs and relationships. In the case of AI, technology itself was an inspiration for many and formed an important techno-material relation for them. While moving towards the question of creative agency, different perspectives were seen in the artists' answers, depicting the human-centred, context-based, more-than-human and co-creative approaches to creativity and creative AI. The relation between the artists and AI varied, and the role of AI was seen either as a tool, a medium or a partner. The closest techno-material relationship between the artists and AI took place in a co-creative process, where both human and nonhuman agencies are creative together. All these results support the idea of co-creativity being a relational phenomenon, where creative processes, social relations, imaginations and techno-materialities meet and affect each other in space, or with respect to creative AI, at and beyond a human–AI interface.

As a theoretical contribution, we introduce the idea of co-creative spatiality to describe and cover the sites and relations where the co-creative process between humans and AI happens. Co-creative spatiality represents an openness to the world that carries and creates potentialities and opportunities for change. Like creativity, it unfolds simultaneously as incidental, experimental and directional worlds, where frictions, play and work are all at hand when humans and AI collaborate in a creative process. Although co-creative spatiality involves new techno-material relations that emerge with the creative agency of AI, it needs to be understood as a multi-sited spatiality that is co-constituted by humans, nonhumans, sites and events together. It represents both more-than-human and posthuman approaches to creativity and space, where the agencies of humans and AI interact, collaborate and are entwined. These new human–technology relations both stretch the existing terrains of human and geographical imaginations and create a spark for new imaginative terrains to happen. In co-creative spatiality, new art is created.

Much has been discussed about the ethical, social and political issues regarding the development of AI, and these discussions should also reach creative geographies. We see that further critical research and profound deliberation of AI is required, but before that, it is important to understand what creative AI is and does and what the new techno-material relations between humans and technology are. Based on our results, we claim that the idea of co-creativity derived from the field of computational creativity is a useful conceptual and empirical opening when it comes to understanding the spatialities, techno-materialities and relational nature of creativity with AI. Our concept of co-creative spatiality brings these discussions into the core of creative geographies, from where they mostly have been lacking. We believe that our research on artists working with AI will interest creative geographers in their prospective explorations of creativity in the age of AI and can lead to new creative doings in the field.

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DATA AVAILABILITY STATEMENT

The anonymised and transcribed interview data will be opened for public access via the AILA research portal of the University of Tampere, Finland (www.fsd.uta.fi/en) after the research project is finished.

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