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Projects and pockets: Time-geographic approach to the creative processes of computer scientists

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ABSTRACT

Creativity is a process where interactions among individuals, resources, and peers bring about novel outcomes. Such processes have fundamentally changed in the digital era as creative activities are increasingly conducted along technologically mediated practices in spatio-temporally multifaceted contexts. This paper investigates the impact of such transformations on creativity by examining the spatial, temporal, and socio-material elements of creative processes. Drawing upon the literature on creativity and economic geography, and utilising Hägerstrand's time-geography framework, this paper presents a geographical approach to studying the creative processes on an individual level. Specifically, the concepts of projects and pockets of local order are employed to investigate spatio-temporal practices, routines, social interactions, and techno-material relationships during creative work. The empirical material involves nine Finland-based computer scientists. Mixed methods, including interviews, research diaries, and space-time maps, are used to document their everyday creative work. The results show three essential pockets where creative work is best advanced: pockets of flow, pockets of insight, and pockets of creative bundles. The findings further reveal how such pockets are disrupted and prevented in the everyday work of our participants due to spatio-temporal fragmentation, accelerating work-pace and ensuing feelings of time-pressure and digital congestion. The implications of the study extend to creativity management, the future of work in knowledge-intensive and creative professions, and the use of geographical methods in empirical process studies.

1. Introduction

Creativity is traditionally defined as a process where individuals produce novel and valuable outcomes (Amabile et al., 1996; Csikszentmihalyi, 2015; Runco and Jaeger, 2012). Creative processes involve various moments from inspiration and insight to implementation and evaluation (e.g., Botella et al., 2018) that emerge from interactions between people, resources, and the environment (e.g., Fortwengel et al., 2017; Hautala and Ibert, 2018). The ubiquitousness of technology in the digital era has fundamentally changed how such encounters transpire (e.g., Creely and Henriksen, 2019; Vermeulen and Psenner, 2022). Indeed, today's creative activities occur along mediated practices, i.e., "multiple yet contingent comings-together of technology, people, and place, and space" (Leszczynski, 2018, p. 18). For instance, work practices are increasingly conducted with mobile internet and communication technologies on virtual platforms (Simpson et al., 2021; Wang et al., 2020). Thus, work is often distributed over multiple locations and hours, as telework, virtual work and smart work have become commonplace (Schäfer et al., 2023). This has resulted in increased spatio-temporal fragmentation of work (Hubers et al., 2018), dissolved boundaries between leisure and work (Field and Chan, 2018), as well as new perceptions of rhythm and the tempo of time (Simpson et al., 2021; Thulin and Vilhelmson, 2022;). Indeed, as the emerging literature indicates (e.g., Colbert et al., 2016; Gomes et al., 2016; Jarvenpaa and Välikangas, 2020), the technology-driven transformations fundamentally shape how, when, and where creative work is done. This study, therefore, provides a geographical account of such processes. Employing a case study with nine computer scientists, the study analyses the effect of mediated space–time practices in creative processes.

Economic geographers have for a long time focused on organisational and regional creative performance (e.g., Harvey et al., 2012; Chapain et al., 2013; Meusburger, 2009), while the role of individual creativity has remained rather implicit. However, individual creative processes are central in all creative processes from regional to team level, and thus merit more research. Indeed, as exemplified by the Covid-19 pandemic (e.g., Elisondo, 2022), creativity of individuals is affected by constraints, tensions, and uncertainties (e.g., Hautala and Ibert, 2018; Schiemer et al., 2022) which are increasingly brought produced

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by technology (Jarvenpaa and Välikangas, 2020; Repenning, 2022; Vermeulen and Psenner, 2022). Past studies on individual creativity have revealed the fluctuation of creativity over time, and the effect of factors such as well-being, positive affect, or emotion (Petriglieri et al., 2019; Smith et al., 2022; Weinberger et al., 2018). However, these studies tend to pay less attention to the space–time relationships in creativity, despite these encounters being central to the way in which creativity emerges (Gong and Xin, 2019; Karwowski et al., 2021; Rutten, 2014). Here, geographers can contribute by examining how space, time, and socio-material relations enable, influence and disrupt creativity, and how the creative process emerges in everyday life. Moreover, a better consideration of spatial and temporal issues responds to the calls for process-oriented creativity studies that have remained scant in previous research (e.g., Fortwengel et al., 2017; Hautala and Ibert, 2018).

To this end, the paper utilises a geographical framework and revisits the time-geography of Hägerstrand (1970) to provide a spatial approach to creativity. Time-geography was developed to analyse the interactions of individuals, materials and environments in space and time (Hägerstrand, 1970; Hägerstrand, 1985). The renaissance of the framework in the digital era has proven that many of its classical concepts are still useful in contemporary geographical research (e.g., Klapka et al., 2020; Schwanen and Kwan, 2012; Shaw, 2023). Thus, the present paper employs the time-geographic concepts of *projects* and *pockets of local* order to analyse how creative processes emerge in different spatial and temporal settings in the context of technologically mediated work. With the projects and pockets, the focus is thus on spatio-temporal practices, routines, social interactions, and material relations. As a result, these concepts reveal how the necessary pockets of creativity are negotiated in the work of computer scientists. The study also examines how the creative processes are disrupted in today's spatially, temporally and technologically multifaceted work environment.

The empirical case study involves nine Finland-based computers scientists whose work is technology-intensive and often spatio-temporally flexible. Their creative processes are examples of scientific creativity that is characterised by skills such as problem solving and that aims for specific outcomes such as code or scientific papers (e.g., Barnett and Romeike, 2017; Sternberg, 2018). Consequently, the paper makes an empirical contribution to research on creativity, and to processual studies in economic geography. With mixed methods, the paper also further develops time-geographic concepts and their applicability in empirical research. The data include interviews, research diaries covering a two-week period, and space–time maps. The research asks the following questions (i) What are creative pockets and what is their role in creative work? (ii) How are the pockets organised and protected? and (iii) How are they prevented or disrupted? As a result, the findings reveal how the unique spatio-temporal configurations affect creative work. Some spatio-temporal practices, i.e. creative pockets, were found to enhance creativity, whereas others hinder it. The results have further implications for creativity management, the future of work in knowledge-intensive professions, as well as the use of geographical methods in empirical process studies.

The paper is structured as follows. First, the paper introduces definitions of creativity from the relevant literature that presents a geographical point of view and consequently problematises the current creativity-related research in economic geography. This is followed by the conceptual framework where the concepts of projects and pockets of local order are defined within the present context. After presenting the data and methods, the results are introduced in detail. The concluding section discusses the most important findings, as well as the potential and limitations of time-geography when studying creative processes.

2. Creative process

2.1. Contextualising creativity in computer science

Computer science embodies several characteristics of what can be called 'new work' meaning work which is highly digitalised, technology-intensive and spatio-temporally distributed (Wang et al., 2020). The work involves digital hardware like computers and smartphones, but also software such as digital platforms, programs, and applications. Activities on and through digital platforms produces spatial multiplicity that extends human activities into the virtual realm (e.g., Ash et al., 2018). Thus, digital tools facilitate creative work (Creely and Henriksen, 2019), and technology can even influence the creative process by enhancing the human imagination or augmenting parts of the process (Lundman and Nordström, 2023; Wingström et al., 2023). People also remain connected with resources, peers, and other networks through the mobile ICTs. Such virtual connections facilitate 'co-presence' (Schiemer et al., 2022) which then enables creative collaboration and play – even without physical proximity (cf., Wijngaarden et al., 2020). Consequently, telework, hybrid work, and distributed work have become commonplace in most knowledge-intensive professions (Schäfer et al., 2023). Subsequently, the spatio-temporal constraints of work and everyday practices have become more relaxed (Colbert et al., 2016; Knight et al., 2022), not least in academia where flexible and distributed work have long been commonplace. Such practices have effects on creative processes: for instance, flexibility regarding workplace and time have been found to have a positive impact on individual creativity (e.g. Liu et al., 2011).

Indeed, mediated creative processes are also deeply embedded in time, as technologies "structure the pace, rhythm and tempo" of activities (Kitchin, 2023, p. 26). For example, technologies can create feelings of time-pressure (Thulin et al., 2019), extend time used for work (Mullan and Wajcman, 2019), or mediate the work-pace (Thulin and Vilhelmson, 2022). Such factors have direct impacts on creative processes, as time-pressure (Amabile et al., 2002; Khedhaouria et al., 2017) and time management (Zampetakis et al., 2010) are associated with positive creative performance in organisational contexts. However, being absorbed with technology can also lead to techno-stress and exhaustion which can, in turn, prevent creativity (e.g., Bunjak et al., 2021). This is also related to the new temporalities produced by technology, such as "network time" defined by speed and connectivity, or instantaneous "real-time" (Kitchin, 2023, p. 35–36), meaning people are continuously in sync with peers. Such "shared temporal structures" have implications for creativity as they shape the spatio-temporal work practices on both an individual and an organisational level (Orlikowski and Yates, 2002, p. 686; see also Pace et al., 2021), and mediate "collective activity" between individuals (Bansal et al., 2022, p. 15). Thus, technology can also change the nature of such interactions (Knight et al., 2022), and reduce time meant for social creativity and inner reflection (Jarvenpaa and Välikangas, 2020). Thus, this paper uses geographical concepts to abstract such mediated time–space practices within creative processes.

2.2. Advancing creativity research in economic geography

The individual creative process has been depicted as the different stages people go through when conducting creative tasks, from preparation to verification (see Botella et al., 2018). In psychology, the process is thus considered to be a mix of biographical variables, personality traits, and cognitive skills (e.g. Karwowski et al., 2018; Martinsen, 2011). The more systemic accounts of creative process have considered how peers, domains, and physical and cultural environment also play a role in creativity (Csikszentmihalyi, 2015). Similarly, economic geographers often consider creativity as an interindividual social process (Anderson et al., 2014). In such a concept, creativity is an implicit part of innovation and knowledge creation (e.g. Gibson, 2016). Indeed, innovation is often seen as "successful implementation of creative ideas" (Amabile, 1988, p. 126). Creativity is, then, closely associated with productivity and effectiveness (Stojcic et al., 2018): it has become "a source of distinct competitive advantage" for organisations and regions (Anderson et al., 2014, p. 1298). In this respect, research has been concerned with factors that enhance or hinder the creative performance

(e.g., Amabile, 1988; Amabile et al., 1996). This means that different variables – e.g., physical settings, time, or organisational structure – are used to measure their effect on creative processes (e.g., Andriopoulos, 2001; Gomes et al., 2016).

Such research has been criticised for the instrumentalisation of creativity, meaning creativity is used as a static resource that can be harnessed for economic growth (see Duff and Sumartojo, 2017). What follows is a positivist understanding of the creative process as a linear phenomenon that can be organised and controlled (Bilton, 2010; Karakilic and Painter, 2022). Therefore, critics have called for stronger process-based approaches to fully appreciate the ambivalent and complex nature of creativity (Fortwengel et al., 2017; Hautala and Jauhiainen, 2014; Ortmann and Sydow, 2018). In point of fact, to better understand the "unmanageable, temporal surprise(s)" of creativity (Karakilic and Painter, 2022, p. 102), we must consider how creative processes emerge in the daily life of individuals. The manner in which creativity fluctuates in daily life has been the subject of research outside the discipline of geography (Czerwonka, 2019). Such diary-based studies have considered how different factors such as well-being (Weinberger et al., 2018), positive affect and emotion (Smith et al., 2022), or stress (Petriglieri et al., 2019) affect individual creativity. To complement these findings, this study provides a geographical approach to individual creativity by focusing on the spatio-temporal configurations and techno-material relations. Thus, this paper adds to the increasing number of studies focusing on the effects of technology and digital mediation on individual creativity (e.g. Cai et al., 2020; Bunjak et al., 2021; Repenning, 2022). Rather than taking a deterministic approach to space or technology, this study aims to accentuate the creative process as a practice, i.e. context-dependent, interactive and fluctuating (cf., Fortwengel et al., 2017). To do this, the paper employs Hägerstrand's (1970) time-geography as a conceptual framework to account for the practices of creative workers in space and time (see also Hägerstrand, 1985; Sui, 2012; Ellegård, 2018).

3. Time-geographic approach to creativity

3.1. The projects and pockets of local order

Hägerstrand and his group developed time-geography to dynamically analyse the movement of corporeal agents, organisms, and materials in space and time (Hägerstrand, 1970; Hägerstrand, 1985; Sui, 2012). Therefore, the project refers primarily to the tasks and actions an individual takes to complete an intended goal. In a broad sense, the project ties together all activities and entities that are required to fulfil a goal, including tangible elements such as objects, and intangible elements such as social interactions, i.e. bundles. The project, therefore, comes together in "fluid space" where its components are "irrespective of their positioning in physical space" (Schwanen, 2007, p. 15). The projects are also deeply embedded in time, as working towards the project's goal requires time. The projects are shaped under certain spatio-temporal and societal conditions, i.e. constraints. For instance, through the analysis of the projects it is possible to trace the constraints on creativity (cf., Ortmann and Sydow, 2018), tensions between individual and organisational creativity (cf., Andriopoulos, 2001), creative clusters and bundles (Törnqvist, 2004), and the materiality of creative actions (cf., Gibson, 2016).

The pockets of local order, in turn, refer to the spatio-temporal configurations that are required to achieve the goal of fulfilling a project. This means the proximity to the necessary resources, social relationships, and the space needed in the project, and the absence of matters that disturb the project. Thus, in classic time-geography, the pockets are rooted in the material landscape that individuals can, to some extent, organise themselves (Hägerstrand, 1985). Consequently, the projects progress better when matters are under control within the pocket. For instance, the home can be seen as a pocket of local order where individuals work on many of the necessary projects such as cooking, childcare and relaxation (Ellegård and Vilhelmson, 2004). Thus, the present paper proposes the idea of a 'creative pocket' to examine where, when, with what, and with whom the creative work is best developed.

3.2. Time-geography in the digital era

In recent years, time-geographic concepts have been increasingly used to analyse human-technology relationships, for instance in terms of mobile ICT use (Thulin and Vilhelmson, 2022), virtual spaces (Shaw, 2023), or accessibility (Dodge and Nelson, 2023). Time-geography offers analytical tools to examine the spatial, temporal, social and technological relationships of human activity, and in this case these concepts are used to study individual creativity in daily life. The paper thus focuses on the conditions under which creativity emerges, similar to research on creative assemblages (e.g. Duff and Sumartojo, 2017) or atmospheres (e.g., Leclair, 2023). However, time-geographic concepts are notably practice-oriented, i.e. the focus is on temporal sequencing of "practices that assemble and bundle people, tools and objects in space" (Thulin and Vilhelmson, 2022, p. 253). Time-geography can thus complement work on spatial creativity by tracing how, where and when the creative encounters emerge (see Schwanen, 2007, p. 19-20). As Latham (2020, p. 707) points out, time-geographic concepts are "heuristic devices" that help to "order and orient accounts of social interaction." To avoid the unduly matter-realistic and physicalist conceptualisations of classic time-geography (see Buttimer, 1976; Rose, 1993), this paper draws on scholars who have developed time-geographic concepts in the digital age (e.g., Ellegård, 2018; Latham, 2020; Sui, 2012). Thus, the paper reworks the classic time-geography's assumptions regarding space–time, agency and presences/absences.

First, to appreciate how creative work is individually practiced, the present study takes note of the rhythms, temporalities and experiences produced by social structures and socio-material relationships (May and Thrift, 2001). Whereas the physical environment and materials play a role in creative work, the creative processes individuals are also shaped by the relational, embedded experiences of space (e.g., Duff and Sumartojo, 2017). Moreover, the creative processes are realised through lived experiences of temporality: the individuals draw from the past, imagine possible futures, and situate their experiences in the present (Zittoun and Gillespie, 2016). The process also involves moments of 'timelessness' where the sense of time is lost – one of the notable examples is the feeling of flow, i.e. a complete immersion in work (Csikszentmihalyi, 2008; Mainemelis, 2002). Thus, the bodily experiences of time cannot be measured with clock-time alone (e.g., Schwanen, 2006). The classic time-geographic concepts must then be complemented with relational views on space and time to better navigate the subjective experience (cf., Massey, 2005). For instance, the pockets of local order can be used to conceptualise the matter-realistic contexts of work with relational and bodily experiences of space and time (Axelsson et al., 2017; McQuoid and Dijst, 2012; Schwanen, 2006; Qviström et al., 2020).

Second, virtual connections and digital spaces contest the physicalist assumption of time-geography regarding presences and absences. For instance, the pocket of local order has traditionally denoted materiality and physical proximity between the elements within the pocket. Thus, the present study relies on the 'virtualised' forms of time-geographic concepts (Couclelis, 2009; Klapka et al., 2020; Shaw, 2023). From this perspective, the 'local' can, and maybe even should, be omitted from the pocket of order. In its place, the local can be used to refer to the relational proximity that can be achieved via virtually mediated communications (Grabher and Ibert, 2017), or to the cognitive proximity in order to describe the shared knowledge base between individuals (Huber, 2012). Although technologies often have an implicit role in the creative pockets due to the "routinization they enable" (Schwanen, 2007, p. 16), their role within the pockets should be made more explicit with a special focus on the material relationships. This also improves the time-geographical work on materiality, as the agency of non-human

entities was defined rather vaguely in Hägerstrand's classic framework (Schwanen, 2007; see also Hägerstrand, 1985, 1995).

In conclusion, time-geography binds together two intertwined approaches. On the one hand, it involves the descriptive spacetime paths that portray an individual's movement, and on the other hand it uses explanatory analyses of the social realm through projects, constraints and pockets of local order (Couclelis, 2009). The latter could still resonate with much of the work by post-structuralists and social theorists. Thus, time-geography links the questions of *where* and *when* creative work is happening with behavioural research which seeks to explain the activity itself (see also Couclelis, 2009; Schwanen and Kwan, 2012; Sui, 2012). Thus, the analysis focuses on social practices, routines, formal and informal rules, as well as material and immaterial resources inherent in all processes, not least in creativity (e.g., Fortwengel et al., 2017; Orlikowski and Yates, 2002; Ortmann and Sydow, 2018). Consequently, the paper advances the state-of-the-art of empirical creativity research in economic geography (cf., Hautala and Ibert, 2018). Thus, a study with mixed methods was conducted, as introduced in the following section.

4. Data and methods

4.1. Case study with computer scientists

The present study involves nine Finland-based computer scientists who work at a Finnish university (Table 1). Computer science is a discipline where creativity is required to create new knowledge and outputs (cf., Barnett and Romeike, 2017; Sternberg, 2018; Wingström et al., 2023). The creative process in computer science often results in distinct outcomes such as new programs or peer-reviewed papers, which are also important as merits of academic performance (Sternberg, 2018). In fact, scientific creativity is considered a distinct type of creativity where specific traits, such as self-efficacy or problem-solving skills, are highlighted (Agnoli et al., 2016). Scientists are also found to possess traits that are associated with creativity, including openness to new ideas, curiosity, and intelligence (Gläveanu et al., 2013). In addition to individual traits, scientific work also resembles systemic creativity (Csikszentmihalyi, 2015), meaning the production of novel scientific outputs requires interaction with peers, editors, funders, and wider networks (Sternberg, 2018).

Each participant collected data over a two-week data collection period between late September and early December 2021. The participants were contacted with a snowballing technique (Tracy, 2019, p. 136). Efforts were made to invite women to participate, considering the gender imbalance within the field (Sax et al., 2017). Consequently, two out of the nine participants were women. The study also aimed to reach participants who were at different stages in their academic careers (Table 1). Further details about the participants were omitted to ensure anonymity. Although all participants had been involved in hybrid work to at least some extent before the pandemic, the amount of remote work increased significantly during the COVID-19 pandemic. Although the aim of this paper is not to compare the pre- and mid-pandemic conditions, the regulations also affected the participants and remote work had become commonplace months prior to the study. During the study period in late 2021, the most severe regulations in Finland had been lifted, and all participants had the opportunity to work or have meetings at the university as well. However, the recommendations to avoid large gatherings were still in place and remote work was subsequently preferred in Finland if possible. Under these unique circumstances, the participants were able to recognise the influence of space and time on their work. For instance, they were aware of whether they worked better at home or in an office, and what kind of factors disrupted or enhanced their work. The study period was thus deemed suitable for the purpose of this study.

Table 1
The participants of the study (as pseudonyms).

Participant	Age group	Position at the university	Main place(s) for work during the study period [**Primary**, secondary]
Anna	26–35	PhD Candidate	**Home**
Benjamin	36–45	Professor	**Work apartment**, family home, university
Elias	36–45	Project researcher/ applied for PhD	**Home**
Joel*	26–35	Project researcher	**Home**, university
Max	26–35	PhD Candidate	**University**, home
Otto	26–35	PhD Candidate	**Home**
Patrik	46–55	Senior researcher	**Home**, university
Sofia*	36–45	Senior researcher	**Office at a private sector company**, university, home
Tobias	36–45	Research assistant	**University**, various other locations such as a train, a friend's place, and home

*Regular work was temporarily disrupted during the study period due to reasons unrelated to the study.

4.2. Mixed methods with interviews, diaries and GPS tracking

The data comprised of three elements: diaries, interviews before and after the study period, as well as location data collected with GPS points. The data collection began with interviews that lasted from 25 to 40 min. The interviews focused on the background information of the participants and involved also general questions specifically about work, i.e., usual tasks, short- and long-term goals, work environment, co-working and daily routines. The interviews also involved questions about pre-Covid times, and whether different places and situations had affected the participants' work. Finally, they were asked to define creativity and elaborate on whether they identify creativity within themselves or through their work. The research period was concluded with follow-up interviews where the participants could freely reflect on the study, and revisit days that were significant, surprising or unusual. The final interviews lasted 20 min on average.

After the first interview, the participants were given a diary, and were asked to complete it over a 'typical' two-week period avoiding if possible holidays or unusual events. Each diary entry consists of two pages; the first pages resembles a typical time-geographic diary (see Ellegård, 2018) including structured questions regarding places, times and work-related tasks. Here, the participants reported their perceived level of creativity, as well as the overall stressfulness and pleasantness of each day. The purpose of this was to allow the participants to better distinguish different emotions during the workdays and to elaborate on their feelings. In the second part of the diary, the participants were asked to describe a specific moment from each day that they felt was significant in terms of their work. This involved open-ended questions including a description of the event, any individual with whom it was conducted, the tools or materials the participant used, and what happened as a consequence of the moment. No pre-determined conditions were assigned at this point, meaning the participants themselves decided what was significant. Because the study focuses on work, some participants chose to omit weekends from the research period.

The diaries were accompanied by location data. The participants were asked to carry with them a SenseDoc 2.0 device (Mobysens Technologies) with GPS tracking capability every time they went outside, i.e., changed location. The data were used to conduct the space–time paths for each participant, which served as the base for further analyses. The raw GPS data were extracted from the SenseDoc devices with the SenseAnalytics software and were first managed as CSV files to determine the start and end times of usage for each day. After the data were prepared, the GPS points were visualised as a map with ArcGis Pro 2.7 software. The GIS analysis also revealed some gaps in the GPS data. Thus, diaries were the primary source for location information on days with less than 60 min of GPS tracking or when the tracking had finished before the participant had arrived at their home location.

The analysis consisted of three phases. In the first phase, we conducted the time-geographical space–time paths from the study days of each participant. Thus, the participants' work was depicted as corporeal movement, i.e., space–time maps, with GPS points. In the second phase, the qualitative data was coded. The interviews were coded to categorise the daily routines of the participants, and their definitions of creativity. The analysis of the diaries focussed on the activities within work-related projects and significant moments. These were coded and classified based on their creativeness, using both the participants' reflections and theoretical insights from the literature (e.g., Botella et al., 2018; Glăveanu et al., 2013). Together, the projects and moments were visualised with the GPS maps "to increase and widen the comprehension of the processual thinking" (Ellegård, 2018, p. 27). Thus, in the third analytical phase, the creative activities were given a spatio-temporal context by cross-examining the GPS data, projects, and moments. Here, the focus was on where, when, with what, and with whom the creative activity occurred. Based on these factors, three types of creative pockets were formed: pockets of flow, pockets of insight, and pockets of creative bundles. The activities and moments where the participants found creative work to be difficult were then similarly coded and classified into five groups: fragmented work, accelerated work-pace and digital congestion, as well as time-pressure and lack of creative time. The results were compared with data from the interviews to verify and complement the creative pocket descriptions, and to further identify the disruptive elements. The findings are introduced in detail in the following section.

5. The creative pockets

5.1. Three types of creative pockets

The first research question investigates the creative pockets, and their role within the projects. Thinking time-geographically, the pockets embody how, where, when, and with whom the participants' work-related projects are advanced. After the analysis, the participants' work was classified into six main projects: programming; meetings and presentations; academic writing and reading; administration work and organising; teaching and supervising. Additionally, studying emerged as a work-related project for Anna, Otto, Max, and Tobias. Based on the empirical data, programming, meetings and presentations, as well as academic writing and reading were classified as the most creative projects. Moreover, particularly programming was highlighted as creative as it requires many creative skills, including problem solving (Patrik, Sofia), developing new ideas and methods (Benjamin) or thinking outside the box (Joel). Such skills are also recognised as creative in previous literature (Runco and Jaeger, 2012), and are characteristic of scientific creativity and work in general (Glăveanu et al., 2013). Academic writing or creating a new presentation were also considered creative work. The participants differed in their opinions about teaching and supervising, as some felt extremely creative while teaching or interacting with students, whereas others saw teaching as a mundane task. Admin work and organising were considered the least creative.

When analysing the conditions under which the projects progressed the most, the analysis revealed three types of creative pockets: (i) pockets of flow, (ii) pockets of insight, and (iii) pockets of creative bundles. The pockets occur nonlinearly and sporadically throughout the creative projects, and facilitated different stages of the creative process. First, the importance of continuous work flow without disruptions was highlighted in both the interviews and research diaries. The diaries included several references to such moments when the participant concentrated on a task, particularly during programming, writing or reading. The pockets of flow appear important when advancing tasks that require engagement and strong cognitive effort, for instance when the creative process is at a stage of immersion, realisation, trials or verification (Botella et al., 2018). Here, many participants mentioned flow as described by Csikszentmihalyi (2008), meaning they felt focused, confident and creative while making progress.

> Before noon I could continuously focus [on a programming task] for a couple of hours and could advance my work efficiently. (*Sofia, from the diary*)

Second, the pockets of insight occurred when the creative process appeared to be at the stage of reflection, illumination, inspiration or ideation (Botella et al., 2018). Namely, the pockets allowed the participant to spend time on ideation, thinking or planning. The tasks within the pockets of insight included, for example, reading, computing, sketching, or merely 'thinking'. Aligning with past literature, the data also showed how such underlying processes of thought occur during longer periods of time, meaning the participants often require several days to focus and refine specific ideas.

> [I] was cycling [at the gym] and thinking of a paper I had read earlier in the day. I began to understand what they were talking about in a specific part of the paper. (*Otto, from the diary*)

Finally, the pockets of creative bundles are perhaps the most well-known since the past literature has long recognised the importance of co-work and social relationships to creativity (cf., Amabile et al., 1996; Csikszentmihalyi, 2015; Jarvenpaa and Välikangas, 2020). Indeed, the creative bundles are critical for participants at all stages of the creative process, from ideation to verification. None of the participants worked in complete solitude, and the research diaries of all the participants except Anna had an example of a creative bundle. These bundles demonstrated that the project had progressed after insight or ideas gained from others, for example during a team meeting, a brainstorming session. Thus, the creative bundles are important at various stages in the creative process, either by providing feedback about a new idea, finding a solution to a problem, or verifying a result with peers.

> During the meeting when my colleague presented his opinions and I presented mine, I felt less stressful compared to yesterday. [Then] I could initiate the work again and build some meaningful insights. (*Joel, from the diary*)

5.2. The creative pockets in space and time

The following answers the second research question and investigates how the pockets are ordered and protected in creative work. In general, the pockets are formed under varying spatio-temporal contexts, as the participants generally have flexible work practices which is common feature in academic work settings. This means the participants enjoy high levels of job autonomy and self-organising, and the work of most participants was distributed among multiple locations or conducted outside the normal nine to five working day. Although home and office were the most common places for work, the GPS data also revealed other locations for work such as trains, or homes of friends and relatives.

The flexible work enables highly individualised work arrangements; for instance, our participants regularly adapted their work to personal schedules, i.e., non-work-related appointments such as health clinic visits or other duties like child-care, or according to their personal needs, emotions, well-being. An example of flexible work practises is illustrated in Fig. 1 with data from Joel. During his workday, Joel started to work from home and had a virtual meeting with a colleague. Then, he travelled to a café to have another, face-to-face meeting. From the café, he moved to his office at the university to work before running an errand when returning home later in the evening. While many of the work activities occurred in physical places, e.g., in the office or at home, work tasks are increasingly situated in online contexts as Fig. 1 also demonstrates. Thus, most of the participants' work could be classified as distributed work or smart work, meaning they altered their workplace and times depending on personal preferences. Here, the spatio-temporal rhythms of the work of our participants "adapt to fluctuations in bodily capacity and well-being" (Thulin and Vilhelmson, 2022, p. 264), i.e.

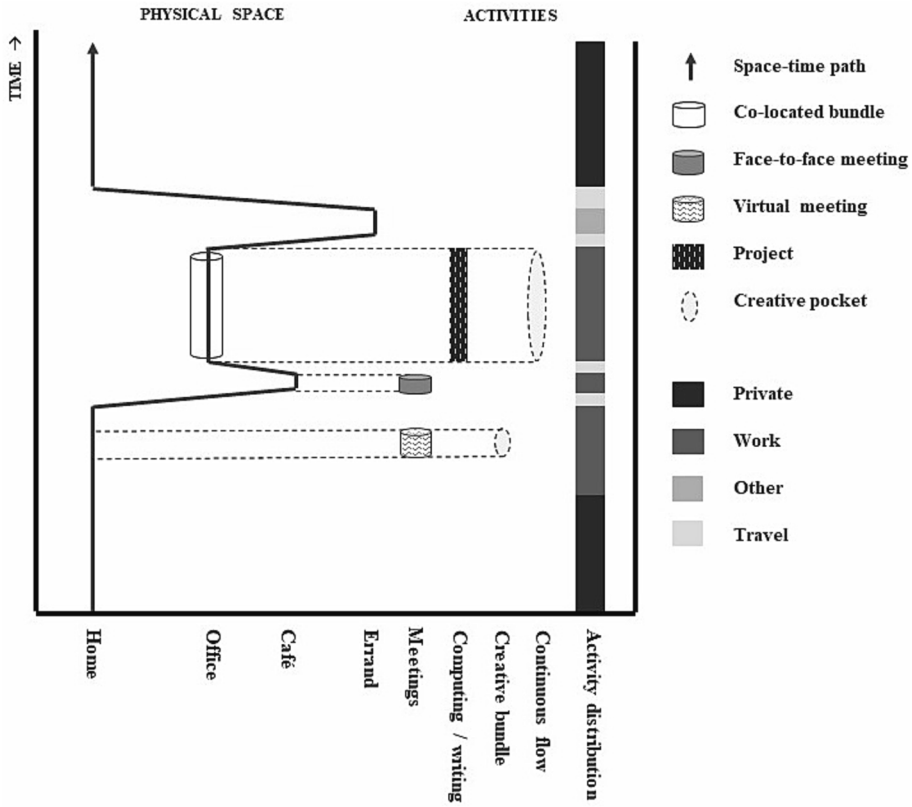

Fig. 1. A simplified time-geographic illustration of Joel's workday.

reach spatio-temporal contexts where they work best.

Despite the varying work settings and routines, the analysis revealed certain similarities regarding the ordering and protection of the creative pockets. For instance, the pockets of continuous flow protected the participant's need to focus on the task at hand. The pockets of flow tended to occur during active work time, and were required to meet upcoming deadlines and finish tasks. Paradoxically, time is often perceived as passing faster than normal within the pockets of flow, and there can be feelings of 'timelessness' when the sense of clock-time disappears (Mainemelis, 2002). In our sample, the participants were most aware of the needs for these in situations where they could work without disturbances. This was perhaps amplified after the Covid-19 pandemic, during which people struggled to work from home due to interruptions from family members or tending to household chores prevented focus:

> My work requires me to ponder about things for a long time, so I'm very annoyed if someone interrupts me [at home] (…). I can [focus] if it's quiet and peaceful [at home], but then again there is the laundry and dishwasher that I might go and fill up. Somehow, I feel that if I have filled up the dishwasher during the work day, and then the work easily spills over into the evening hours. (*Sofia, second interview*)

Consequently, the pockets of flow are easiest to order in spaces that facilitate solitude, but they can be also be formed during circumstances where working alone is not possible. For instance, while working in a shared office, the participant can create walls around the pocket by absenting themselves from the physical proximity others, i.e. by using another room for work. Relative distance can be also be produced by other means, like using headphones while working. This is exemplified in Fig. 1, which depicts how Joel manages to reach a pocket of flow in an office despite the presence of peers.

The results also suggest that the physical characteristics of office spaces, i.e. insufficient desks, or a lack of air-conditioning during warm summer days, might influence how, where and when the pockets are ordered. For instance, several participants pointed out how they avoid teleworking from home for it lacks an 'adequate atmosphere', meaning some atmospheres might facilitate the creative pockets better than others. This was evident particularly with pockets of insight, as the data involved some examples of interconnections between spatial experience and insight. For instance, a walk along a forest path facilitated timelessness, calm thoughts, and consequently a pocket of insight in the diary of Patrik. This also extends to the temporal context, as demonstrated in the following quote from Joel:

> If I have to do work where I need my complete focus, let's say writing a paper or something, I will do it at night because I have utter silence and I can focus more. (…) If I have to develop mathematics, attend meetings, or code, I generally do it in the morning because I feel this time is the best for those things. (*Joel, first interview*)

Moreover, in contrast to the pockets of flow, the sense of time-pressure was notably absent in the pockets of insight. Instead, the temporal dimension within the pockets of insight was usually characterised through abundance of time, meaning the participant had 'time to think' in that pocket. The pockets can thus also form when the participant is physically distant from work, and the examples included exercising at the gym, driving in a car, or during a walk. In fact, some participants emphasised that they distanced themselves from work in order to have more room for thoughts. Indeed, as Gong and Xin (2019) also found, creative individuals require tranquil moments and spaces to find balance in the buzzy and fast-paced environments.

In contrast, in the pockets of creative bundles, proximity to peers is the most critical element within the bundle. This means physical or virtual proximity, and often incudes cognitive proximity, meaning all the individuals in the bundle are focusing on the topic at hand. The immediate connections are critical in the pockets of creative bundles, half of which occurred in virtual settings or via mediated communications in the sample. Here, the mediated communications, as well as both

online and offline meetings, generate shared temporal structures (Bansal et al., 2022; Orlikowski and Yates, 2002): these practices facilitate the creative bundles. Thus, most of the creative bundles were pre-scheduled. There was only a small number of spontaneous creative bundles, which usually formed when the individuals were physically proximate and had enough time to bundle. The importance of the spontaneous bundles was highlighted in the interviews, for many participants appreciated the social dimension of workplaces, and for this reason, some preferred an office over a home as a workplace.

6. Creative pockets disrupted

6.1. Spatio-temporally fragmented work

The final research question investigated how the creative pockets were prevented or disrupted. The analysis suggests there are three spatio-temporal contexts in contemporary work that seem to pose challenges to creative work, and thus require further attention; spatio-temporal fragmentation, the pace of work and digital congestion, and a lack of creative time.

First, whereas flexible working arrangements increase the possibilities for creative pockets, work distribution can also involve factors that disrupt the creative pockets. The GPS data shows how the participants' work days were spatially fragmented, meaning their work was distributed over multiple locations. The motivation for this was usually in-person meetings or teaching. For instance, the participant might begin working at home but later commute to the university to have a meeting, or they may use a smartphone to co-operate with colleagues during a sports training session (Fig. 2). As a consequence, the participants' work tended to become temporally fragmented, i.e., work is paused while traveling between locations. Thus, the fragmentation during the workday could also stretch the workday into later in the evening; an example is shown in the Fig. 2, where Sofia returns to her workplace later in the evening to continue work on a project after training. Sometimes, the temporal fragmentation was present without spatial dispersion. For instance, home-based telework was a source of fragmentation when the household chores were performed sporadically or simultaneously with work tasks (cf., Hubers et al., 2018). The participants described their workday as fragmented even when working at the same location the entire day due to having to switch between several projects and tasks. For instance, Benjamin describes how he "only had a limited possibility" to focus on other work tasks between "of online meetings and other phone calls." The fragmented days were thus particularly detrimental for the pockets of flow, if the fragmentation prevented longer work segments.

The fragmented days exemplify how the participants are constantly negotiating between overlapping projects, both work-related and personal. Usually, pre-arranged communications and tasks with deadlines were prioritised, whereas less-urgent tasks were put on hold. The results further revealed a critical difference between the early-career and the later-career researchers. On a daily average, the former (Anna, Elias, Joel, Max, Otto and Tobias) focused on tasks relating only to one or two projects. For example, Elias, Joel and Max mostly spent their work days programming, whereas Anna and Otto were focussed on writing. In contrast, the latter group (Benjamin, Patrik and Sofia) juggled with tasks from two or three projects, and had to focus on communications, organisation, and administration work more often than the others. The results highlight the characteristics of an academic career path, where early-career researchers are mostly busy with single projects, like programming or working on a PhD study. In contrast, the later-career researchers tend to be more involved with project management and administration work and have less possibility to work on creativity-

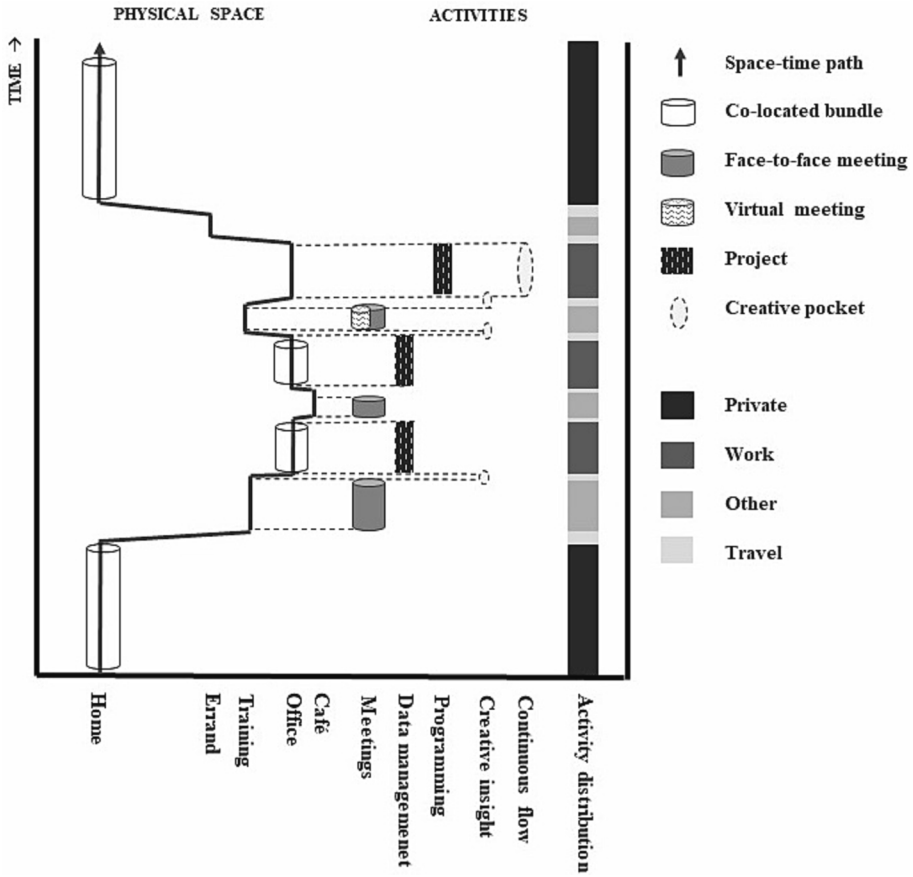

Fig. 2. A simplified time-geographic illustration of Sofia's fragmented workday.

intensive tasks like writing or programming. The experiences of time-pressure and stress are prevalent particularly among the late-career researchers if their organisational duties reduce the time they can spend on research.

6.2. The pace of work and digital congestion

This increased fragmentation is linked with the accelerating pace of work and digital congestion that are common in knowledge-intensive fields (Hubers et al., 2018; Simpson et al., 2021). The data suggests that the participants struggle to order creative pockets in the digital work environment where the spatio-temporal contexts are ubiquitously formed via technology (Ash et al., 2018). Paying attention to the role of technology and artefacts within the creative pockets allows analyses of their role beyond being mere tools for human work. Rather, they are critical agents that have the capacity to shape – or disrupt – the pockets (Schwanen, 2007). For instance, running an automated computer model materialises temporality; the progression of the command can be followed in clock time, which can then have implications for experiences of time-pressure and stress.

> [Today] I ran a neural network with two inputs. I had to be very careful, because this operation takes about two days to complete, and on Monday [I must show it to my supervisors.] (*Elias, from the diary*)

The most prominent examples of the materialised space–time practices are caused by mobile ICTs and mediated communications. The participants relied on mediated communications, i.e. emails, phone-calls or other forms of instant messaging, to keep up with their peers and research groups. Often, the participants felt that the communications required immediate action and thus disrupted, delayed, or prevented their other work. Therefore, the participants were always negotiating between being available to peers and being absent in order to focus in peace on the task at hand. Therefore, the participants seem to require a great capacity to organise creative pockets without being disturbed by communication flows. As Elias states in his interview, concentration on work is difficult after he "starts to receive emails and phone calls", hence the reason why he likes working in the morning.

Thus, technologies transform creative practices by transforming the way creative workers communicate and collaborate. Critically, the digital congestion and increased spatio-temporal fragmentation transform and disrupt the temporal structures that are known to influence collective activity in organisations (Bansal et al., 2022). The findings align with past literature that has found mobile ICTs mediate the work-pace and generate a shared sense of time amongst groups and communities in which the individuals are spatially distant (Kitchin, 2023). However, the past literature also suggests the digitally mediated temporal structures of spatially distant individuals are more unpredictable than the temporal structures formed at a shared workplace (Thulin and Vilhelmson, 2022). Indeed, the pockets of creative bundles are vulnerable to unsynchronized work practices where the individuals fail to find shared rhythms of creative work. Moreover, most pockets of creative bundles were ordered during pre-scheduled meetings and only a few diaries involved examples of spontaneous meetings with peers that resulted in creative action.

6.3. Time-pressure and the lack of creative time

When summarising the findings from the past two section, it appears that the role of time merits further attention. In the diaries, many participants expressed their lack time for creative tasks, i.e., projects such as programming or writing. In fact, the participants had a varying capacity to control their time-use and allocation of work. Time is of course a limited resource, as the classic time-geographic framework has emphasised (Hägerstrand, 1970), and the lack of time is generally detrimental not least in the context of creative pockets. However, the results highlight how time in the creative pockets is not only an organisational resource but rather unfolds in multiple dimensions, including both clock-time and a relationally experienced 'inner time'. Certainly, the increased fragmentation and digital congestion caused experiences of the lack of time, which was consequently associated with time-pressure and stress (cf., Thulin et al., 2019). The experiences of time-pressure were also increased when the participant encountered problems or setbacks with tasks, for instance, when programming took more time than anticipated. Time-pressure prevented the participants from fully focusing on their present tasks, because time-pressure tends to anchor focus in the future and demands a great capacity to plan ahead.

Past research suggests a link between creativity and time management (Zampetakis et al., 2010). Moderate time-pressure has been found to sometimes facilitate flow and creative thinking (e.g., Amabile et al., 2002; Khedhaouria et al., 2017), and time-pressure was sometimes present in the creative pockets of flow as considered earlier. However, there seems to be a fine line between good and bad time-pressure, and higher levels of time-pressure noticeably disrupt creativity (Amabile et al., 2002). For instance, Anna reported having difficulties organising her tasks while teleworking, and her diary records feelings of frustration on days she "spent the entire day going through and sending emails", or "making sense" of her tasks in general. Her feelings of stress overshadow and hinder her creativity:

> [I] felt overall very stressed today, and therefore I could only concentrate a little [on work] and I did not do anything creative, not even a little amount. (*Anna, from the diary*)

Time-pressure, fragmentation and digital congestion can significantly reduce the much-required inner time, i.e. 'time to think' that is essential in creative work. However, the need for inner time is a rather overlooked part of the creative process, despite being extremely critical as it allows ideation, reflection and insight. Nevertheless, the contemporary fast-paced work environment only offers a little space and time for pockets of creative insight. For instance, Patrik expresses frustration when he lacks time to work on his own research, including novel research questions or ideas. In addition to underlining the paradoxical issue of researchers not having time to conduct research in academia (cf., Pace et al., 2021), the following quotation is a reminder of how creative tasks are also critical to well-being and engagement in work:

> [During the second week] I even got a little coding done. So, you kind of secretly start doing research. You have a sort of longing for it. (…) I get so much satisfaction [when I'm finally able to work on my research], no matter how much stress I have had. (*Patrik, second interview*)

Academic work often highlights productivity, and this is visible in our results as well. Indeed, the importance of creativity beyond its productive value is poorly recognised. The 'creativeness' of the participants is measured in outcomes, and consequently many participants associate creativity with productivity. Thus, the critical time meant for inner reflection and insight might be viewed as unproductive if there are no immediate or concrete results. Moreover, the emphasis on outcomes overshadows the implications of creative experience on work well-being and motivation. We therefore reflect on these results in the concluding discussion.

7. Concluding discussion

The new era of work has changed the spatial and temporal contexts where creative work is conducted (cf., Wang et al., 2020; Elisondo, 2022; Jarvenpaa and Välikangas, 2020; Karwowski et al., 2021). The present study depicts creativity as being beyond a simple organisational resource; it is a a process that emerges from and is shaped by spatial and temporal conditions. By approaching creativity from an individual's perspective with a time-geographic framework, the paper explored the creative work of nine Finland-based computer scientists over a two-week study period. The empirical study comprised of mixed methods:

with interviews, research diaries and GPS tracking. Thus, the creative work was analysed with the time-geographic concepts of project and pockets of order. As a result, the paper identifies three types of creative pockets where creative work is best advanced. These pockets – continuous work flow, insight and creative bundles – facilitate creativity in different phases of the creative process.

As a first contribution to the subject, the paper has empirically provided insight into the spatio-temporal arrangements of individual creativity and creative work. The importance of collaborative spaces and co-working has been widely recognised in past research (e.g. Schiemer et al., 2022; Wijngaarden et al., 2020) and while adding to these findings, the results have also increased the understanding of individual creativity; this has been done through the concepts of pockets of continuous flow, as well as pockets of insight. With regard to these concepts, the results show how creative work requires time to reach the feeling of flow, to reflect and ideate, and to focus on the task at hand. These moments are rooted in spatial, temporal and socio-material characteristics that the workers arrange and order for their creative pockets. Furthermore, the results align with studies that associate flexible work with more freedom, positive emotions and creativity (e.g. Liu et al., 2011). Based on the results, the presence of mobile technologies was critical in many creative pockets as virtual connections and digital resources enable spatio-temporal flexibility. Indeed, the creative pockets are rarely ordered 'locally' as the classic time-geographic use of the concept suggests. Rather, they are constituted in multifaceted spatio-temporal contexts that spread to far-reaching spatial, temporal, material, virtual and social dimensions (cf., Ash et al., 2018; Thulin et al., 2019; Wingström et al., 2023). The results simultaneously demonstrate that there is no one-size-fits-all situation in which individuals can advance their work and that while the office at the university may be essential for the pocket of flow for one person, the home-based office might suit another person better. Thus, organisations should be mindful of the effect of space on work when promoting remote work or open offices even if work is mostly conducted with digital resources or on virtual platforms. Indeed, future inquiries into creativity should consider how individual creative processes comprise of moments of collaboration, flow, and solitude, and whether these moments are connected to specific spatio-temporal contexts.

Second, the results revealed how the creative pockets are disrupted. These disruptions had several causes: the spatio-temporally fragmented work, the accelerating work-pace, as well as time-pressure and digital congestion. Thus, the positive effect of flexible work practices can paradoxically increase fragmented work and disruptive mediated communications that, in turn, hinder the ordering of creative pockets. For instance, the spatio-temporal fragmentation of work might increase desynchronization amongst creative individuals, especially if the shared temporal structures that are digitally mediated are more unpredictable (Thulin and Vilhelmson, 2022). The lack of spontaneous bundles present in this sample raises questions regarding the nature of collaborative creativity in this new era of work. Thus, we need a better understanding of what happens when the spatio-temporal practices of co-workers are desynchronised, or when collaborative creativity is constrained to specific and prearranged spatio-temporal settings (Jarvenpaa and Välikangas, 2020). Moreover, several participants mentioned the lack of time for creative work caused by fragmentation and the accelerating work-pace, usually in the context of continuous work flow. The results also suggest the participants lack 'time to think' which results in a small number of pockets for creative insight during workdays. However, as past literature has also found, these tranquil and peaceful moments are essential in creative production (e.g. Csikszentmihalyi, 2008; Gong and Xin, 2019; Mainemelis, 2002). Although technology facilitates much of the creative work and enables many activities, it seems that the creative process also requires moments where such connections are absent. Indeed, particularly the moments of incubation, reflection and insight seem to be related to spatial contexts where people achieve peace and quiet (see Gong and Xin, 2019). In this sample, such spaces emerged for instance during walks in the forest or while working out at the gym. Thus, future studies should pay attention to such spatio-temporal configurations that facilitate 'dead time', and how they could be also accounted for under organisational settings.

Third, relating to the previous point, the results suggest that the more mundane parts of creative work are poorly recognised. For instance, the passive stages of creativity were rather implicit in the diaries and interviews, whereas the active creative work was accentuated. For instance, the participants reported feeling most creative when reaching clear outcomes, such as research reports, code packages, or smoothly running computational models. This suggests a strong association between creativity and productivity that requires further scrutiny. Certainly, organisations tend to promote creativity while striving for productivity (Stojcic et al., 2018), not least in academia where the quality and amount of research outcomes are used as important measures of scientific merit (Sternberg, 2018). Thus, the pressure to produce novel outputs, particularly under strict deadlines, was also present in this study, and was related to experiences of stress and time-pressure. Thus, the outcome-oriented views on creativity perhaps undermine the importance of the everyday creative experience from the perspective of well-being and motivation at work. In other words, the significance of creativity going beyond its actual productive value is poorly recognised, also by the participants themselves. Future studies must endeavour to scrutinize better the role of productivity in creativity definitions, and whether the extant methods used in organisational creativity measure the creativeness of people, instead of their productivity (cf., Amabile et al., 2002; Khedhaouria et al., 2017).

As the fourth contribution, the paper has shown how the classic geographic concepts of the project and the pockets of order can be reworked to fit contemporary geographical research. Indeed, by employing mixed-methods, the paper spotlights the everyday contexts of creative work that cannot be fully traced with positivist accounts of creativity as an organisable phenomenon (Duff and Sumartojo, 2017; Karakilic and Painter, 2022). Thus, combined with the spatio-temporal maps created with the GPS-data, the mixed methods created a strong basis on which to scrutinize creativity in a spatial and temporal context. The in-depth data provided an individual-level account of the creative work in everyday contexts, and complemented the extant diary-based studies on creativity (cf., Czerwonka, 2019) with a strong geographical perspective. The study also adds to the process-oriented creativity studies on a micro-level that have remained limited in economic geography research (Hautala and Ibert, 2018). Although the method is applicable to various process studies, and can be paired with various data sources, it must be noted that involving a large number of participants might reduce the depth of the analysis because of the increase in the number of data points. Moreover, research that utilises daily GPS data must involve a thorough ethical consideration to validate the use of such sensitive information and to ensure the security of the participants. The method should thus be adapted to suit the case study in question.

Finally, creativity is a complex issue; its definitions continue to be debated and often vary between fields (Runco and Jaeger, 2012). Thus, certain critical issues regarding creativity, such as the mechanisms of the precarity of creative work (Comunian and England, 2020), are beyond the scope of the present paper. Moreover, assessing the influence of the Covid-19 pandemic restrictions remained limited as the study setting did not involve a follow-up survey. Sociodemographic factors have also been found to play a role in individual work arrangements, as well as wellbeing at work (e.g., Hubers et al., 2018). Thus, whereas this study does not allow generalisations based on gender or household structures, such issues could be considered in the future under similar methodological settings. These issues are critical for contemporary creative work that is exposed to transformations due to technological, organisational and societal changes (Vermeulen and Psenner, 2022; Wang et al., 2020). Indeed, as the results reveal, technologically mediated work practices merit further scrutiny as they have several implications for creativity and creative work. Future research should carefully consider the lives of

creative individuals as a whole in order to understand the future of work from their perspective.

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Data availability statement and data deposition

The data of the study will not be opened for public access to ensure the protection of the personal data of the participants.

CRediT authorship contribution statement

Roosa Wingström: Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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