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Knowledge creation rhythms of a science project in and beyond remote Ny-Ålesund in the Arctic

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This article discusses how a temporary gathering of researchers in the remote and peripheral Ny-Ålesund research station (78°55'N, 11°54'E) affected the rhythms of knowledge creation in an international research project. Periods of co-presence are crucial for creating knowledge in projects whose members usually work in different geographical locations. Gathering to cities and clusters has been shown to be practical and beneficial, but not enough is known about the meaning of a peripheral place for knowledge creation or how the process continues afterwards. Also, the role of the physical-natural environment for knowledge creation is too little understood. Therefore, in this article, we apply Henri Lefebvre's rhythmanalysis and its basic concepts (polyrhythmia, eurhythmia, arrhythmia, isorhythmia) to investigate the work of a research group during and after their field campaign in Ny-Ålesund. According to the key results, the gathering in Ny-Ålesund supported an intense and focused eurhythmic ensemble in which rhythms were aligned, the environment became a participant in the knowledge creation process, and a spur in knowledge creation was achieved. However, as the rhythms changed, also the eurhythmia started to dissolve. By zooming in time and space, beyond the gathering, we notice that knowledge is created further through an arrhythmia, an arrhythmia that may also be necessary for achieving innovative scientific knowledge.

Keywords: Arctic, Ny-Ålesund, rhythmanalysis, knowledge creation process, co-presence, periphery

Introduction

Knowledge creation processes are generally organized into international projects in current knowledge economies and 'projectified' university research (Fowler et al., 2015). In a scientific knowledge creation process, preliminary ideas are carefully and often empirically analyzed and compiled into justified and interpreted entities of arguments

(Plato, 1977; Popper, 2000). Conducting such a process in an international project means that members are dispersed internationally into various project sites. Research has shown that co-present groups outperform geographically dispersed ones (Nguyen-Duc et al., 2015). Therefore, internationally dispersed groups gather together at times to foster collaboration and create a shared understanding that is needed to continue the knowledge creation process apart (Hautala, 2017).

However, from a geographical perspective, the analysis of such knowledge creation processes in space and time calls for further development (Ibert et al. 2015). Regarding space, it is not yet well known *where* the project should gather for co-presence or how this environment affects the knowledge creation process (Rutten, 2017; Torre, 2008). Because projects and their knowledge creation processes are different, they likely also benefit from gathering into different kinds of environments at particular times: the 'where' is not a 'passive backdrop' for activity (Edensor 2010, p. 7). However, most empirical examples of gathering places concern urban centers and clusters (Gibson, 2012; Grabher & Ibert, 2014). Empirical research on knowledge creation processes in peripheral sites has emerged only recently (Gibson, 2012; Glückler, 2014; Hautala, 2015). In addition, current research often predefines the empirical scope in space. For instance, in geography, it is common to focus empirically on a spatially pre-defined entity, such as a territory or organization (Ibert et al., 2015; Rutten & Boekema, 2012). Such a view does not sufficiently focus on the individual who is creating knowledge and is mobile across organizations and territories. In regard to time, its linear understanding dominates the knowledge creation research (Hautala & Jauhiainen, 2014), and is reflected in a common empirical strategy to follow knowledge creation during a short-term meeting (e.g., a conference) (Bathelt & Schuldt, 2010) but not before or beyond the gathering, or a

common analysis that seeks one generalizable linear trajectory for knowledge creation (Verduyn, 2015).

This exploratory study advances these current approaches by acknowledging that projects may have many trajectories of knowledge creation by their members that coincide through the repeated pattern of gathering into co-presence and dispersing. We adopt a process perspective of knowledge creation research (Ibert et al., 2015; Verduyn, 2015). To analyze knowledge creation from a process perspective, combine time and space, and closely analyze the meaning of a physical-natural environment for knowledge creation, we apply Henri Lefebvre's (2004) rhythmanalysis. Although most often connected to music, Lefebvre sees repetitive but constantly changing rhythms everywhere. In such rhythms, space, time, and energy are combined, for instance, into a knowledge-creating scientist's daily routines. These routines are rhythmic, bodily practices of the scientist: breathing, moving, communicating, thinking, using laboratory equipment, eating, etc. Rhythmanalysis turns attention to sensory and emotional experiences of individuals who are living the rhythms in a particular environment (Lefebvre, 2004).

In this article, we investigate the knowledge creation rhythms of an interdisciplinary and international research project ArcticABC (Arctic Ocean ecosystems - Applied technology, Biological interactions, and Consequences in an era of abrupt climate change) during and after its two-week gathering in Ny-Ålesund. Ny-Ålesund (78°55'N, 11°54'E) in Svalbard in the High Arctic is the northernmost research station settlement in the world. It would be considered extremely remote and peripheral in the geographical research on knowledge creation. In centers, various rhythms of knowledge creation co-exist and structure organizations, projects, and people's everyday lives (Friedmann, 1999). Such 'buzz,' intensity and multiplicity are usually considered

beneficial to knowledge creation (Bathelt et al., 2004). Controversially, peripheral and remote locations, such as Ny-Ålesund, include fewer actors and rhythms connected to human activity than centers. The rhythms of the natural environment, however, exist everywhere. The Arctic is considered a 'laboratory for scientific research' (Heininen, 2005), and Ny-Ålesund has become a key site for the collection of scientifically valuable empirical data in various fields (Ny-Ålesund Science Plan, 2015; Roberts & Paglia, 2016).

We ask the following questions: (1) Through what kind of rhythms is knowledge created in the ArcticABC project? (2) What significance does the temporary gathering in Ny-Ålesund have for knowledge creation in the project? As a result, we show how the Ny-Ålesund field campaign became an intensive eurhythmic ensemble that aligned rhythms into a harmony, advanced the knowledge creation, and affected the project's later phases. However, by following the project rhythm further and 'zooming out' to the whole project ensemble, we noticed that an arrhythmia (disharmony of rhythms) persists. This arrhythmia may be necessary for creating valuable knowledge, but it kept distracting the progress.

Scientific knowledge creation in the temporary and remote project site

Scientific knowledge is created in actual places and their local social cultures, environments, and wider political and economic processes (Livingstone, 2003, p. 4; see also Lefebvre, 1991; Roberts & Paglia, 2016). Hence, scientific knowledge is not a 'view from nowhere' (Shapin, 1998, p. 5). International scientific projects are conducted in various locations, at times the members work apart, and at times they gather together. This repeated pattern connects various sites into one knowledge creation process.

According to an extensive review of empirical research, geographical dispersion hinders knowledge creation: it creates risks of misunderstandings, difficulties in coordination, and delayed reactions to problems (Nguyen-Duc et al., 2015). In contrast, co-location facilitates 'local buzz' (i.e. active and even spontaneous interaction) (Bathelt et al., 2004). In co-presence, individuals experience and are aware of each other (Gertler, 2003; Grabher et al., 2018). Co-presence enables a strong shared understanding of the project's aims between the members, which, in turn, sustains knowledge creation during dispersion (Hautala, 2017). In the emerging approach in geography that analyzes knowledge creation as a process in space and time (Ibert et al., 2015), co-presence is examined through temporary clusters such as scientific conferences (e.g., Bathelt & Schuldt, 2010), and repeated gatherings (Hautala, 2017; Storme et al., 2017). However, it is not well known where the project ensemble should be moved for the periods of co-presence or how this environment affects the knowledge creation process (Rutten, 2017; Torre, 2008).

In this article, we contribute to this need from two angles. The first angle concerns the significance of remote Ny-Ålesund for knowledge creation. Geographers have studied much about creating knowledge in centers, cities, and clusters (Gibson, 2012; Grabher & Ibert, 2014). These spaces are often characterized by easy access and vast pools of resources like materials, innovative universities, and individuals (Gibson, 2012; Porter, 1998; Rodríguez-Pose & Fitjar, 2013). Such elements support the creation of global high-level scientific knowledge, but their dearth restricts knowledge-based economic growth (Fitjar & Rodríguez-Pose, 2011; Petrov, 2008). Research that is explicitly focused on the benefits of peripheral places for knowledge creation has emerged only recently (e.g., Glückler, 2014; Grabher & Ibert, 2014; Hautala, 2015), and it has shown that remote places can be sources of creativity (Gibson, 2012; Grabher, 2018; Grant et al., 2014), and

temporal disconnection from domain-related networks provides time to focus and space to work (Hautala, 2015). However, most of these studies' locations are not very remote but are small cities and suburbs (e.g., Bain, 2013). In science, the key locations of the collection of empirical data that can challenge and bring novel results to existing research may well be extremely remote (Geissler & Kelly, 2016).

The second angle concerns the meaning of the physical-natural environment – such as the weather and available materials – in knowledge creation, which is not yet understood enough (Alcayna-Stevens, 2016; Faulconbridge, 2010). The most commonly studied physical spaces of knowledge creation are more general geographical locations, areas, and indoor offices (Hautala & Jauhiainen, 2014). Although analyzing the significance of the environment is central to geography, the common empirical focus is on larger units such as regions and organizations. However, more research on individuals and groups is called for (Faulconbridge, 2014; Rutten & Boekema, 2012) – and their knowledge creation processes do not stop when one steps out of the office. Instead of geography, in science and technology studies, the meaning of the physical-natural environment and the place of scientific work is a key subject (Henke & Gieryn, 2008). The environment is experienced through a body that is a researcher's 'research instrument' (Geissler & Kelly, 2016; Alcayna-Stevens, 2016). A historic building as a meeting place advances the creation of heritage knowledge better than a meeting in a modern facility does (Yarrow, 2017). However, the 'sensory and affective dimension of fieldwork' (Alcayna-Stevens, 2016) and the connection between an intensive knowledge creation process and remote sites (Geissler & Kelly, 2016) remains too little understood even in this discipline.

Rhythmanalysis for knowledge creation research

Rhythmanalysis studies phenomena as interrelating and continuously varying rhythms – the confluences of time, space, and energy. According to Lefebvre (2004, p. 15), rhythms are '[e]verywhere where there is an interaction between a place, a time and an expenditure of energy. Thus, the world is full of rhythms from breathing to Earth's rotation. Rhythms are repetitive cycles that grow, peak, and decline although each detailed cycle is different (ibid.).

Rhythms are relative only to each other, and these relations constantly re-form in their interactions in a place: '[R]hythms imply the relation of a time to a space, a localised time, or, if one prefers, a temporalised space. Rhythm is always linked […] to its place' (Lefebvre, 2004, p. 89). Various rhythms of humans and environment become intertwined in places and result in the rhythmicity of places like research stations or cities (see, Smith & Hetherington, 2013). Also, Hägerstrand's (1982) time-geography combines time and space. However, the empirical time-geography analysis focuses on mobility in time-space diagrams and lacks the sensory and embodied nature of the analyzed process (Edensor 2010, p. 1). Scientific knowledge creation is based on daily routines of moving, communicating, thinking, using equipment, etc. These are the scientist's sensory and bodily practices (Geissler & Kelly, 2016; Alcayna-Stevens, 2016; Valtonen et al., 2017), and can be detected with rhythmanalysis.

Rhythmanalytical studies have demonstrated how interaction and bodily engagement with the social and material environment generate knowledge of that environment (Pinder, 2011; Straughan & Dixon, 2014) and how to act there (Edensor & Holloway, 2008). Still, rhythmanalysis has been sparsely applied to knowledge creation processes. Rather, one can find rhythmanalysis in neighboring topics such as education (e.g., Middleton, 2014), organizational learning (Fahy et al., 2014; Rowe, 2015), creative fields (Jones & Warren, 2016), and entrepreneurial processes (Verduyn, 2015).

The process perspective and rhythmanalysis rest on an ontology of becoming and movement (Verduyn, 2015). According to the process perspective, knowledge creation has no clear starting or ending points (Langley et al., 2013). The same is true for rhythms (Lefebvre, 2004, p. 89). Rhythms change – either gradually as the scientist learns, or more dramatically as the scientist changes research environment, for instance. Thus, mobility and change alter rhythms. Here, the environment includes other people, objects, and the physical-natural environment with its various rhythms.

However, it is not enough to observe how phenomena move and change in the course of time across space. Rhythms have a 'qualified duration' instead of a quantified one (Lefebvre, 2004, p. 78): rhythms are lived and sensed in everyday life through people's corporeal, sensory bodies (Lefebvre, 2004, pp. 19–23). Changing sensations and emotions – denoting changes in temporal and spatial perception– are the marks of rhythms. Therefore, Chen (2016, p. 2) understands a rhythm as a meta-sense or a mode of meta-sensing that synthesizes not only identifiable and bodily impressions but also non-identifiable and extra-bodily impressions. The focus is on 'moods' and 'atmospheres' (Lefebvre, 2004, p. 87) (i.e., also on the role the physical-natural environment has in knowledge creation).

Ensembles of rhythms

Rhythms constantly interrelate and form ensembles, 'bundles' of associated rhythms: in the ensemble of a body, each organ's rhythms interrelate and form a larger whole (Lefebvre, 2004, pp. 20, 68). A city, for instance, is an ensemble consisting of its various localities' individual rhythms (Osman & Mulíček, 2017). Still, a certain city can be considered to have its specific rhythm differing from the ones in neighboring towns. Similarly, although nested, a campus, department, and an office room have their particular

rhythms, embodied and also produced by their users (Jauhiainen, 2007). When each ensemble has its rhythm and belongs to other ensembles, rhythmanalysis allows moving between and along them (i.e., 'zooming in' and 'out' in time and space). The act of zooming allows the foregrounding of certain aspects, or rhythms, in focus, bracketing of others, and then re-positioning again, so broader understanding is reached (Nicolini, 2009).

The interactions of the rhythms in an ensemble can be described as *polyrhythmia*, *eurhythmia*, *arrhythmia*, and *isorhythmia* (Lefebvre, 2004, pp. 16, 20, 68). Given rhythms' fluctuating nature, they can also be understood as particular moments of varying duration in an ensemble; an arrhythmic ensemble can transform into eurhythmia and vice versa. Everything seems to be a polyrhythmia 'from the first listening' (Lefebvre, 2004, p. 16): rhythms unite, co-exist, and encompass multiplicity (Chen, 2016, p. 5). Therefore, in a brief observation, the normal course of events in a project can be described as polyrhythmic. However, if it is examined more carefully, differences and particularities arise (Lefebvre, 2004, p. 16).

Eurhythmia is a harmonic association of rhythms (Lefebvre, 2004, p. 67). In a scientific project, group members' rhythms are co-aligned toward shared aims, timetables, and divisions of tasks, which supports knowledge creation. Conflict between different rhythms implies arrhythmia: 'a divergence in time, in space, in the use of energies […] a disassembly' (Lefebvre, 2004, p. 68). Hence, arrhythmia refers to friction and tension that may arise, for instance, when group members' senses of time and work rhythms do not coincide (Syring, 2009) or when knowledge creation rhythms are adjusted to follow a bureaucratic and project-based funding system (Jones & Warren, 2016). Lefebvre (2004, pp. 67–68) also mentions isorhythmia, the rarest occasion, which occurs

when ‘a rhythm falls into place and extends over all the performers however many they may be.’ It is the ‘equivalence’ and ‘equality’ of rhythms.

For geographers, it is common to consider (urban) places ensembles as Osman and Mulíček (2017) did. However, similar to rhythms, ensembles vary from ‘corpuscles to galaxies’ (Lefebvre, 2004, p. 42). In our study on knowledge creation in ArcticABC, a repeatedly dispersed project, we outline two important collections of rhythms. The first ensemble is formed during the field campaign from the interaction of several researchers’ rhythms, the key objects they use, and the rhythms of the physical-natural environment in Ny-Ålesund. Another ensemble, the whole project, requires zooming out in space and time from the gathering to the project’s overall knowledge creation processes.

Project, site, and empirical study

ArcticABC: Researching biological Arctic life with innovative technology

ArcticABC (Arctic Ocean ecosystems - Applied technology, Biological interactions, and Consequences in an era of abrupt climate change) (2015–2019) is directed from the University of Tromsø (UiT) and has over 40 members affiliated with various institutions in six countries. The key objective is to better understand ecosystem activities in the Arctic Ocean, especially during the polar night. Here, the knowledge gaps are enormous (Werner et al., 2016), and the demanding conditions require heavy and investment-intensive sampling programs (Berge et al., 2016). Moreover, the Arctic environment is subject to increasing and profound changes (Petrov et al., 2016).

ArcticABC’s first sub-objective is to develop drifting observatories, ‘POPEs’ (ice-tethered platform clusters for optical, physical, and ecological sensors), which facilitate Arctic marine research. They are planned to autonomously collect and send various types of real-time data from the Arctic Ocean year-round. The project’s engineers

design and configure the POPE's software and hardware based on the needs of the users, the biologists. The members of the technology team focusing on POPE development come from UiT, the Norwegian University of Science and Technology (NTNU), and the Scottish Association for Marine Science (SAMS), some holding an adjunct position at the University Centre in Svalbard (UNIS) (Figure 1). At the time of our investigation, in 2017, the POPEs development was ongoing. We chose ArcticABC for this study for two reasons. First, it is a typical contemporary academic project – international, interinstitutional, interdisciplinary, and aiming at breakthrough innovation. Second, the study required an empirical example of a gathering in a very remote and peripheral location, which Ny-Ålesund is. Author Ojala's previous experience of living, studying and conducting empirical field research in Svalbard supported our focus on Ny-Ålesund.

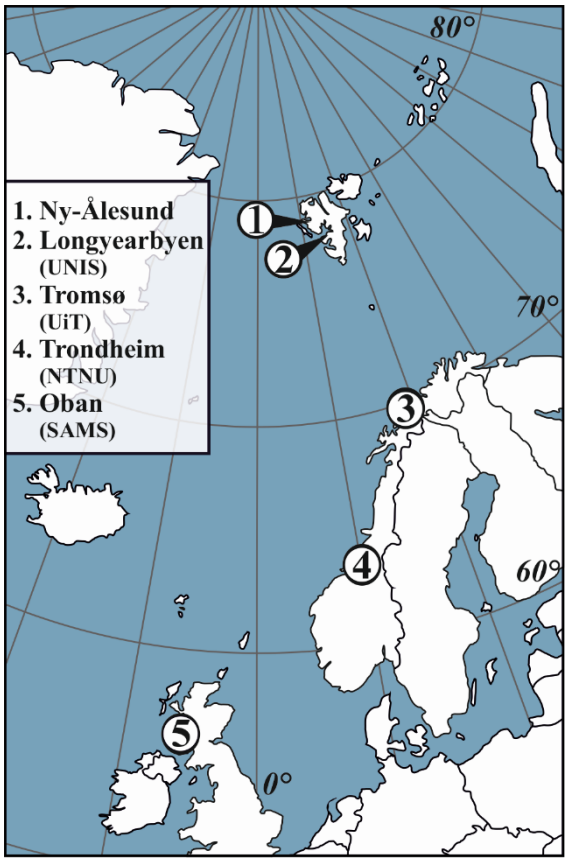

Figure 1. Locations of Ny-Ålesund and the home institutions of the ArcticABC technology team members (map by Ojala).

The site: Ny-Ålesund, a remote research station settlement

The Arctic is considered a 'laboratory for scientific research' (Heininen, 2005), and Svalbard – an archipelago administered by Norway – has become a key site for scientific activities. Ny-Ålesund in Svalbard (Figure 1), is the northernmost research station settlement in the world. The location and facilities allow access to valuable empirical data regarding local, global, and planetary processes in various fields (Ny-Ålesund Science Plan, 2015; Roberts & Paglia, 2016). International research activities are allowed (Svalbard Treaty, 1920) and promoted (Ny-Ålesund Science Plan, 2015), but the research stations and shorter-term activities also imply the actors' statuses as political stakeholders in Arctic issues (Roberts & Paglia, 2016). A Norwegian state-owned company, Kings Bay, operates the town and its infrastructure. Its staff and the users of year-round human-

crewed stations form the basic population of approximately 30 people. In winter, the number of actors stays at this minimum, but during summer months, it may increase to 200.

As a research station settlement, Ny-Ålesund can be considered a small center, but it is extremely remote and isolated for three reasons. First, no neighboring towns exist, and Ny-Ålesund lacks travel connections. To enter, one must first travel to Longyearbyen, the main town of Svalbard. From there, no roads lead to Ny-Ålesund. It can be reached through the use of a propeller plane, a cargo ship during summer, or one's own means requiring special arrangements. The transportation is expensive and dependent on weather and ice conditions. Second, Ny-Ålesund is enclosed by wilderness, which poses several threats, such as extreme weather conditions, challenging terrain, and roaming polar bears. Therefore, incoming researchers must commit to the organizational practices developed for securing and controlling everyday life in Ny-Ålesund. Third, Ny-Ålesund is an area with regulations about radio silence to ensure that the fine-tuned equipment collects proper data. Therefore, no wireless network is allowed. People may contact each other with fixed-line phones or radio phones on agreed-upon channels. Also to use other radiofrequency equipment, such as the POPEs, permission must be requested from authorities. However, high-speed internet – available through cables – connects the otherwise peripheral station worldwide in real-time.

Empirical study: Rhythmanalyzing the ArcticABC project

Lefebvre (2004) does not provide exact practical instructions for rhythmanalysis, but his ideas include cornerstones that we applied in this research. First, a rhythmanalyst 'grasps' the rhythms by being grasped by them in *presence*, as they are lived (Lefebvre, 2004, pp. 21–23). This requirement supports ethnographical methods: participant-observation in the place of co-presence. Second, Lefebvre (2004, p. 87) urges the rhythmanalyst to pay

more attention to ‘moods’ and ‘atmospheres’ rather than particular events. Therefore, the participant-observer does not focus only on what, where, and when something happens. Attention is also given to sensations and emotions that can be considered the marks of rhythms and their qualified durations. Third, and connected to the process view, rhythms should be followed in time and space (Lefebvre, 2004, p. 16).

Following the above guidelines, Ojala joined six members of the technology team on their two-week field campaign in Ny-Ålesund. Three members were engineers focused on developing the POPEs, and the other focused on administrating a related UNIS course. Also, the project director and two other project members arrived to teach the course that started on our third day in Ny-Ålesund. A mixture of project engineers and biologists was present. Ojala joined their everyday activities, from work to meals and informal gatherings. Her desk was next to the engineers’, which made an intensive observation and occasional discussions possible. The main material was collected in January 2017: detailed field notes (incl. discussions), photos, and video recordings that all support an ‘attentive memory’ required for rhythmanalysis (Lefebvre, 2004, p. 36). Moreover, 14 semi-structured interviews with the ArcticABC members, six engineers and eight biologists (mean length 19 min; median length 17 min) were carried out. The interviewees include also members who did not attend the field campaign

To ‘zoom-out’ from the ensemble in Ny-Ålesund to the project ensemble, the rhythms were followed further. Ojala participated in the annual meeting of the entire project in Trondheim in October 2017, took part in Skype meetings, and received information through e-mail before and after the campaign. In addition, project documents (a project plan, 17 meeting minutes, and two field reports) and public outreach material from the ArcticABC webpages were included in the analysis.

The analysis follows the hermeneutic phenomenological methodology, for it has several similarities to rhythmanalysis. Both aim at new understanding by describing the elusive lived experience (Adams & van Manen, 2017). Strict categorizations and step-by-step procedures are rejected; theorizing is an ongoing process toward a plausible description, including collecting material, re-analyzing, and re-writing. Lefebvre (2004, p. 14) highlights that defining rhythms depends on the criteria, scope, and the person who puts them into perspective. In this article, we make these interpretations by considering the project members' experiences and the project's aims. As a rhythmanalyst, who 'calls on all [her] senses' and 'thinks with [her] body' (Lefebvre, 2004, p. 21), Ojala also observed her own sensations, emotions, and actions. These experiences are fused into the analysis. However, the key focus is on the material concerning ArcticABC project members. In the following, we first zoom in to the ensemble in Ny-Ålesund. Then, we zoom out to the whole project ensemble and consider the rhythms of knowledge creation beyond the campaign.

Knowledge creation rhythms in and beyond Ny-Ålesund

In Ny-Ålesund: A eurhythmic ensemble of focused knowledge creation

> Ny-Ålesund is a unique place. It is magic in many ways. Ny-Ålesund […] is dark, is cold, is wet, is slippery, is full moon, it is very white mountains, it is a bit scary, it's polar bears around our field expedition... Ny-Ålesund is the place that could be well defined outside of Earth, and the fact that we are working here is a privilege. (Engineer)

The quote above describes Ny-Ålesund's physical-natural environment as magical and scary. Indeed, the campaign was a clear and extraordinary breakaway from our everyday practices. Transferring the project to Ny-Ålesund and withdrawing from everyday life had required careful preparation. The campaign had forced to build synergies with related

activities because, as one member remarked, 'it's insanely expensive to be here and it's quite some to get [everything] here and back again.' Simultaneous timing with a biology cruise that transported us and the various instruments to Ny-Ålersund and a related UNIS course enabled the necessary people and objects to be at the same place at the same time. The researchers had also packed their equipment carefully because, as one member explained, 'in Ny-Ålesund […] if you're missing one key element, you don't have the store around the corner.' Also, the participants' schedules had been cleared of other tasks. Focus on the campaign – the trail of the eurhythmia to come – had started much before the actual journey. A remote place supports focused working (Gibson, 2012; Hautala, 2015), and the campaign in Ny-Ålesund was deliberately built into an ensemble in which various rhythms could interrelate and co-align.

We arrived at Ny-Ålesund around noon, but due to polar night, it was cold and dark around the clock; only a waning moon and electric lamps provided some light (Figure 2). This was also the quietest season regarding activities: only the basic residents – fewer than 30 people – were present. One of them remarked that ArcticABC broke the long period of silence. Indeed, we caused slight changes in the prevailing ensemble. For us, merging was easy; Kings Bay's services and infrastructure ensured our stay, we had appropriate gear, some had been there before, and all had experience related to fieldwork in the Arctic.

Figure 2: Ny-Ålesund when we arrived (*upper left*). Engineers working in the lab (*lower left*). On a boat, going to deploy one POPE offshore (right). (Photos by Ojala)

During the first days, practical arrangements, such as unpacking the equipment and shoveling snow, required the project members to stay awake until night. Soon, a daily routine was established. It was guided by our sleep-wake cycles and ordered by strict meal times. The area is small, and so were our everyday routes (Figure 3). A little shop, museum, shooting range, sauna, and the Internet provided some – but not much – pastime. Most mundane, time-consuming obligations were absent; the chores were taken care of, and the commute was extremely short.

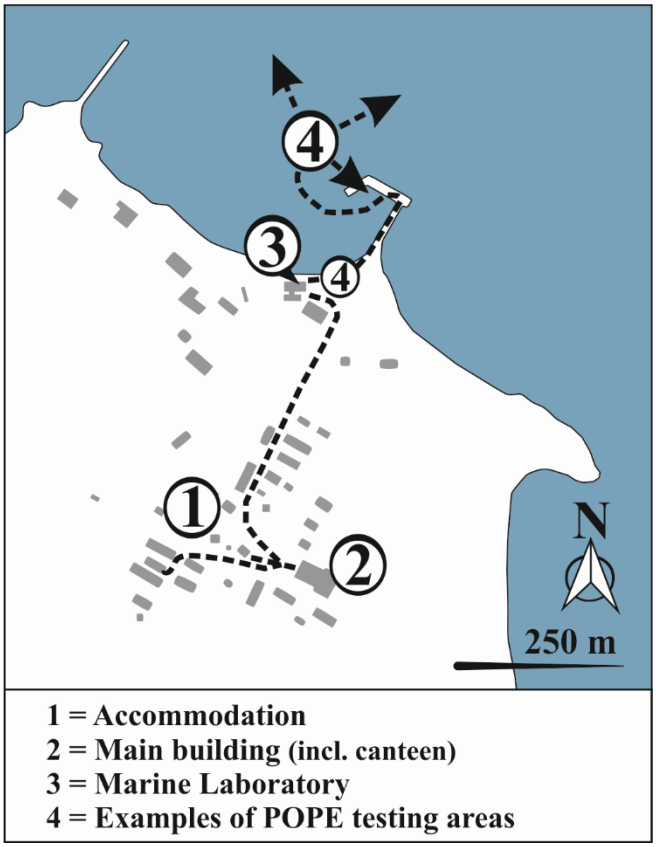

Figure 3. Key paths and sites of the everyday work in Ny-Ålesund. (Map by Ojala)

Due to the darkness and coldness, we preferred to stay indoors. Most additional 'noise' was absent, the necessary elements were present, and the financial investment was high; the mindset of devoting oneself to work was clear:

> The challenge in ArcticABC has been to put everything together. And that is something that happened here in Ny-Ålesund. Here we have science, engineering, and material, and tools together, plus the boats for the logistics, right, so we can do the whole cycle at the same time. (Biologist)

Work days became long. The key engineers focused on developing the POPEs' software and hardware and testing their capability to receive and transmit data in the Arctic, in underwater conditions, and over distance. Others ran the UNIS course and supported the engineers when needed. Engineering work required several tests and iteration. Sometimes POPEs were tested inside and sometimes they were carried outside or even further to the

sea. We learned the best practices to act by confronting and interacting with the prevailing rhythms. Earlier research has documented similar adjustment of individual diurnal and seasonal rhythms to coincide with the environmental rhythms (Vannini & Taggart, 2015), or to slow down during the polar night (Rantala & Valtonen, 2014). Engaging with the environment also stimulates haptic learning immediately: bodily micro-movements change in response to the rhythms nature imposes (Straughan & Dixon, 2014). In the lab, for instance, dry air and the resultant static required caution when one worked with circuits. Working outside was even more constrained by elemental forces; movement was careful and slow. POPE deployments offshore, for instance, included several time-consuming stages: securing safety nets, putting on a clumsy wetsuit, and loading and off-loading the boat. The Arctic environment is uncertain and challenging and requires skill (e.g., navigating in the darkness among blocks of ice), strength, and teamwork:

> We were about to put out to sea. I was told to bring a big case to the shore. I stood by it, grabbed the handle, lifted – and was suddenly flat on my back on the ice-glazed ground, the case lying beside me. Later on, I saw also [member] falling over as he climbed the slope. However, the boat got stuck to the shore because of the ebb, and after a struggle we asked also the engineers to help. (Ojala's diary)

Long durations spent outside resulted in freezing toes, tiredness, and hunger. In the presence, the darkness, coldness, slipperiness, wetness, and a heavy blizzard appeared as arrhythmias in knowledge creation, as they caused delays and inconveniences. However, these distractions can also be considered eurhythmic, pushing knowledge creation further. The POPEs must bear these circumstances; they are developed to collect data in the rhythms of the Arctic and not be disrupted by them. Thus, the physical-natural environment not only confined our focus to the work but also became a key participant in knowledge creation. Jones's (2010) rhythmanalysis documents similar relation in creative work between artists and tides. The Arctic environment tested the POPEs, the

POPEs reacted, and the engineers interpreted the reactions and developed the POPEs further. Also, as polar scientists, these scholars need to maintain and advance their skills in managing in the Arctic.

We also got to know each other better; some of the members had met only once. The interaction was relaxed, constructive, and frequent between the project members: even discussions during meals were related to the project. The necessary people, objects, and the natural environment were engaged in meaningful co-presence, and an intense, eurhythmic knowledge creation ensemble formed for the project:

> This is the dynamic environment where misunderstandings are cleared up in, and it becomes quite obvious what is good and not good. (Biologist)

Eurhythmia also resembles a moment of 'flow': group members engage in meaningful and challenging knowledge creation during which time seems to disappear (Csziksentmihalyi, 1997). Similarly, Lefebvre (2004, p. 76) refers to appropriated time as 'time that forgets time' during 'plenitude' that one may achieve in work, for instance. In addition to flow-like moments, in our case, appropriated time refers to hours the campaign was able to appropriate, or 'steal,' for the project – hours the members would have otherwise spent differently.

The eurhythmia spurred knowledge creation forward: misunderstandings and uncertainties were detected and solved, new ideas were created, plans were updated, people learnt about each other, and the project progressed in building the prototypes. However, eventually, the eurhythmia began to dissolve. Interestingly, many of the same reasons that enabled focus started posing arrhythmias on it. Although the Arctic polar night conditions and small area restricted our activities to work, after time passed, I observed that the monotony they caused began to strain slightly. Pastime activities were limited, and the wonders of Ny-Ålesund were explored quickly. Also, the company was

the same throughout the days and did not compensate for the social relations back home. The departure dates prompted the scholars to work efficiently, but they also forced us to finish and start packing in time. The peak of the eurhythmia had been reached, and gradually, thoughts from the presence were turned toward the future as preparing for the return and life outside Ny-Ålesund took over.

Beyond Ny-Ålesund: Dispersed knowledge creation and arrhythmia

As an international project, the polyrhythmic ArcticABC repeats the cycle of working apart in dispersion and gathering either physically in the same place or through electronic communication. In both ways, the project members' rhythms of knowledge creation become relational to each other. Gatherings and e-meetings offered moments leading to shared understanding, as expressed by the project director (a biologist) regarding the engineers:

> I have learnt that some of the project participants are magicians. They do things that I did not think are possible. I learnt that the project is actually going ahead in a very, very solid manner. I get more and more confident. (Biologist, January 2017)

Certainly, the gathering in Ny-Ålesund was a consolidating moment when the dispersed rhythms were aligned. However, the moments of eurhythmia also dissolve. Rhythms and ensembles are constantly transformed by new ideas, needs, possibilities, restrictions, people, and places – changing the understanding of the POPEs and the project. These changes become evident when we zoom-out from Ny-Ålesund to the whole project ensemble and further in time. Indeed, by the meeting in Trondheim in October, the design of one POPE had changed drastically, and one key member was no longer part of the project.

ArcticABC combines the fields of technology and biology, which have different cultures of working and different rhythms of knowledge creation. Using terms of the wide

geographical research on knowledge creation, biologists and engineers have a cognitive distance that makes finding a common understanding difficult (Boschma, 2005). Also, the practical cycles in their work differ. The biologists aim to understand specific natural phenomena. Their work is greatly defined by the temporal rhythms of the environment they study: data on ecosystem activity during the polar night can be collected only during the polar night. The engineers' work is less dependent on natural cycles. They aim to design novel technical equipment that functions accurately. Progress in advancing them is not straightforward but requires iteration and resampling. If one piece transforms, the equipment as a whole may need re-building. New ideas from the biologists or weaknesses shown through the natural environment require a restart and delay. If cooperating people's work rhythms do not 'mesh,' friction and tension arise (Syring, 2009, p. 137). In ArcticABC, the rhythms collide, for instance, if the POPEs should be used on a biological field campaign but the engineering work is delayed, a frustrating situation for all.

Indeed, combining the two fields had led to an arrhythmia that persisted in the project ensemble even before and during the period of our research, as exemplified by the following quotes:

> We are two different, h'm, we talk different languages, for that has been a challenge. (Biologist, January 2017)

> We understand what is said, but the thing is that this requirement changes a lot. So we built what we are required to build but people who define the requirements are not really sure what they really want and need. (Engineer, January 2017)

> It might also be we think we're talking about the same thing but we are actually talking about different ones. An example, even simple thing, the timing of a cruise, let's say December, can be interpreted differently. Ten days' difference is huge in engineering. (Project member, Ojala's diary, October 2017)

> We don't yet know what the biologists want […] we let them go back and forth.
> (Engineer, Ojala's diary, October 2017)

In addition and related, the members distribute their work to several other projects as well. All have their own, possibly overlapping, deadlines and bureaucratic requirements that cause arrhythmias in academic work (Jones & Warren, 2016).

According to Burstrom and Wilson (2018), high levels of complexity actually assure tension in innovative projects. A pleasant social atmosphere and a 'nice bunch of people' were commonly agreed upon as one of ArcticABC's success factors. Although these aspects had not prevented the arrhythmia, they have likely prevented it from becoming fatal. The project members also considered themselves learning to better understand each other and the project as a whole. Simultaneously, the POPEs and the project are being advanced through the alternation of eurhythmias and arrhythmias – if the latter remain moderate. Finally, given the nature of rhythms, isorhythmia as a consensus and the equity of rhythms is perhaps only ideal for a scientific project or something achieved as a project's outcome. In the latter case, however, the innovative goal has been reached, and knowledge creation may already be directed elsewhere.

Discussion and conclusions

This article contributes to the need to better understand the geographies of knowledge creation processes in international project groups that gather temporarily and work otherwise in geographical dispersion (Hautala, 2017; Nguyen-Duc et al., 2015). In particular, we are interested in the gathering's '*where*,' about which enough is not yet known (Faulconbridge, 2010; Rutten, 2017). The 'where' suggests focusing first on the little-studied meaning of peripheral and remote place for knowledge creation and second on the little-understood meaning of physical-natural environment for knowledge creation.

Our ethnographic study concerns knowledge creation in the ArcticABC project before, during, and after a key gathering in the remote Ny-Ålesund research station. Hence, we follow knowledge creation from the process perspective (Ibert et al., 2015; Langley et al., 2013). To support the process perspective, to combine time and space, and to analyze the physical-natural environment closely, we applied rhythmanalysis (Lefebvre, 2004).

To answer the first research question of through what kind of rhythms knowledge is created in the project, we identified the characteristics of polyrhythmia, eurhythmia, and arrhythmia. Moreover, we suggested isorhythmia to describe perhaps an unattainable ideal of complete consensus in knowledge creation. *Polyrhythmia* is a more general rhythm of knowledge creation in the international project via gathering and dispersing. When zooming in to the ensemble of the Ny-Ålesund field campaign, we recognized an intense *eurhythmia* during which the members were engaged in co-presence. Rhythms were co-aligned, and knowledge creation advanced significantly. During the eurhythmia, arrhythmias also supported knowledge creation, which advances the empirical findings on the benefits of distractions and tensions (e.g., Burstrom & Wilson, 2018; Stark, 2011). However, when zooming out to the whole project ensemble, we recognized a more comprehensive arrhythmia that was inherent to ArcticABC. The project combines two fields, biology and technology, to achieve scientific breakthroughs. When connected to a geographical dispersion that fosters misunderstandings (Nguyen-Duc et al., 2015), the arrhythmia challenged knowledge creation and resulted in delays and frustration. Because rhythms can only be grasped in the *presence* (Lefebvre, 2004, pp. 17, 21–23), without the (co-)presence with others, individuals' rhythms for creating knowledge can be differentiated more easily. This is an interesting notion for geographers, for whom the meaning of co-presence is at the core of the research agenda (Grabher et al., 2018).

To answer our second question of what significance the temporary gathering in Ny-Ålesund has for knowledge creation in the project, we described an intense eurhythmic ensemble in Ny-Ålesund with focused and harmonic knowledge creation that spurred the project toward its aims. The campaign was deliberately built into an ensemble in which associated rhythms could interrelate. The eurhythmia could not have been achieved anywhere or by any project. In our study, the 'timeless remoteness' of a research station (Geissler & Kelly, 2016) was enhanced by Arctic polar night conditions, limited resources, a pleasant social atmosphere, and the experience's uniqueness. These factors enabled the co-alignment and co-presence of the dispersed rhythms during the temporary gathering. Although remote places block many actors and their rhythms (the buzz), in such places, one may strongly experience other rhythms: the rhythms of other project members, relevant objects, and the physical-natural environment. The Arctic environment also had a voice through its rhythms as they indicated weaknesses and strengths in the knowledge creation process. Responding to these hints transformed the arrhythmias actively into eurhythmias.

This article supports previous findings that co-presence is important for creating knowledge in geographically dispersed project groups (Bathelt et al., 2004; Grabher et al., 2018; Hautala, 2017; Nguyen-Duc et al., 2015). As rhythms can only be grasped in the presence, without the (co-)presence with relevant people, objects, and the physical-natural environment, individual rhythms for creating knowledge can differentiate more easily. Our study shows that the exclusion of excess rhythms and retreating away from the buzz may benefit focused knowledge creation and assist in achieving engaged co-presence. Moreover, we suggest that the physical-natural environment can participate in knowledge creation. In some cases, these findings might be used to choose the gathering place. Whether a particular environment can support knowledge creation depends on the

task, field, and timing. Rhythms change, and a similar eurhythmia might not be created in Ny-Ålesund for ArcticABC in another phase.

Finally, this article presented an exploratory study of one project. We suggest three topics for further research. First, because rhythms ought to be followed until their end (Lefebvre, 2004, p. 16), it would be interesting to study how the ArcticABC project ensemble develops in the longer term. Second, the meaning of peripheral places for knowledge creation processes should be analyzed among an extensive sample. Third, rhythmanalysis accentuates that both space and time are socially and politically produced (Elden, 2004, pp. 192–198; Lefebvre, 2004). In future studies, rhythmanalysts could 'zoom out' even further in time and space to analyze scientists and science projects in relation to the diverse political and power dynamics of which they are indeed a part (Edensor, 2010; Roberts & Paglia, 2016). Zooming to these wider rhythmic ensembles would provide important insights on how scientific knowledge creation rhythms evolve.

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