Now together, next apart: Knowledge creation processes through repeated geographical dispersion

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Abstract

Economic geographers have, for a long time, analysed the meaning of geographical co-presence and dispersion in knowledge creation. Recently, interest has shifted towards the process approach and the levels of individuals and groups. Despite this, little empirical research has been conducted following the knowledge creation process "here" (including on-site observation) and "now" (not ex-post) in groups through repeated geographical dispersion. This case study follows four project research groups in Finland led by foreign, distinguished professors. These groups created knowledge during a repeated pattern of geographical co-presence and dispersion. The study covers a seven-year period from the beginning of the projects and going beyond their completion, including three intensive periods of collecting empirical materials. The results demonstrate that a cognitive locus of a shared understanding of the project focus is key for creating knowledge during periods of geographical dispersion and even beyond the ends of project periods. The results show three types of cognitive loci that are created in three patterns of geographical co-presence and dispersion. Each of the three combinations supports particular outcomes and the continuity of the projects in Finland.

Keywords: co-presence, dispersion, geographically dispersed groups, knowledge creation process, cognitive locus

Introduction

The mobility of highly skilled experts is increasing (Jöns 2009; Skeldon 2009; Trippl 2013; Rérat and Jeannerat 2014) and becoming more important for the development of industrial organisations and research systems (Geuna 2015). In universities, international project groups and mobility are supported by visiting fellowships and second affiliations. In business organisations, mobility is required in international collaboration projects between sub-offices and external partners. The majority of international project groups sometimes create knowledge together and sometimes apart. Therefore, the groups are repeatedly faced with the challenge of geographical dispersion, which has been found to hinder knowledge creation systematically (Nguyen-Duc et al. 2015). At times of geographical dispersion, certain knowledge-creating practices that are supported by co-presence are unavailable. Most importantly, there is no spontaneous face-to-face communication or shared material environment such as a laboratory. A shared context has been found crucial for dispersed groups in creating knowledge (Hinds and Mortensen 2005; Wlazlak and Johansson 2014; Nell et al. 2016). Successful groups, then, need to develop shared contexts that allow continuing knowledge creation during dispersion.

Knowledge creation is a focal and proliferating topic for economic geographers (Howells and Bessant 2012; Bathelt and Cohendet 2014). Within this topic, research is emerging (Rutten and Boekema 2012; Bathelt and Cohendet 2014; Cole and Barberá-Tomás 2014; Faulconbridge 2014; Hautala and Jauhiainen 2014; Rutten 2014; Vallance 2014; Ibert et al. 2015; Ibert and Müller 2015) that focuses on *processes* of knowledge creation from perspectives that use space as an analytical lens (Bathelt and Glückler 2003) – in the case of this article, in the form of repeated geographical dispersion and shared contexts during and beyond geographical co-presence. Starting from the process instead of a territorial unit such

as a cluster or region, the emerging line of research has been called a move "from cluster to process" (Ibert et al. 2015). The entry points of the empirical research are individuals, groups, their social contexts and practices (Faulconbridge 2014; Rutten 2014).

This article contributes to answering two needs in economic geographical research on knowledge creation, and thereby develops further the emerging process perspective. First, by analysing processes of knowledge creation, this article helps to answer the call in economic geography for study of the meaning of repeated geographical dispersion in knowledge creation (Moodysson 2008; Ibert et al. 2015). This call is identified in research on temporal clusters and business travel (Bathelt and Schuldt 2008; Faulconbridge et al. 2009; Müller and Stewart 2016), and analysis of the benefits of distance (Grabher and Ibert 2014; Glückler 2014; Hautala 2015). Indeed, so far economic geographical literature on knowledge creation has been "bifurcated" into one strand studying settings of co-location and another dispersion (Bathelt and Henn 2014, p. 1403). Prior empirical interest has been in local learning, (temporal) clusters and territorialised approaches where co-presence exists – also called proximity bias by scholars criticising it (Grabher and Ibert 2006; Rutten and Boekema 2012; Faulconbridge 2014). Only recently have economic geographers started to study the knowledge-creating interaction of actors who do not co-locate permanently (Gertler 2008; Bathelt and Turi 2011; Grabher and Ibert 2014; Maskell 2014). Research on geographically dispersed groups is conducted within organisation and management studies, rather than within economic geography. However, even there, studies on knowledge creation through *repeated* dispersion are scarce (Klimkeit 2013). As a result, the details, success stories and failures of knowledge creation processes through repeated geographical dispersion are unknown.

Second, derived from the need for a more nuanced understanding of knowledge creation processes through repeated geographical dispersion in economic geography, there is

a need to develop a suitable process-based empirical research strategy. Empirical research on a process requires long-term data (Moodysson 2008; Ter Wal and Boschma 2011; Hashino and Otsuka 2013) throughout a relevant period, such as a project, and even beyond projects. The empirical research requires a focus on the basic units of knowledge creation processes – individuals and groups (Faulconbridge 2014; Rutten 2014; Rutten 2016). In general, economic geographers focus on wider units such as clusters, organisations and communities when studying knowledge creation (Hassink and Klaerding 2012; Rutten 2016; Rutten and Boekema 2012; Faulconbridge 2014). A key observation is that most micro-level empirical materials about knowledge creation in economic geography take only an ex-post snapshot of a moment (Maoret et al. 2011), which leads to a moment bias. To avoid this, the data should be collected "here" and "now" alongside the process.

Developing the stock of empirical research that follows knowledge creation processes in groups also requires the development of suitable analytical concepts. This article adopts a constructionist-cognitive understanding of knowledge as collectively constructed but individually interpreted. Such an understanding of knowledge is yet to be developed in the economic geographical research on knowledge creation, which is mostly based on rational and constructionist understandings of knowledge and related analytical concepts and empirical methods (Hautala and Höyssä 2017). The concepts for examining the contexts shared by group members in this article are, therefore, selected based on the constructionist-cognitive understanding of knowledge.

The aim of this article is to provide a rich empirical analysis of knowledge creation processes through a repeated pattern of geographical dispersion and co-presence of (project) group members. The following research questions are asked: 1) How do the groups create knowledge during geographical dispersion? 2) How do co-presence, and patterns of co-

presence and dispersion, support knowledge creation during the project and beyond the project period?

As the key contribution, the article presents empirical case studies that follow knowledge creation processes through repeated geographical dispersion in four high-level international research groups and their four projects from their starts to beyond their ends. The groups belonged to the Finland Distinguished Professor Programme (FiDiPro), which funds projects in Finnish universities led by eminent, international professors. These professors are expected to work in person in the Finnish university for 4-6 months per year, which creates a repeated pattern of geographical co-presence and dispersion. The main empirical materials, consisting of interviews, weekly diary reports and observation, were collected during three intensive phases (the beginning of the project, after one year, after the end of the project). Altogether, they cover seven years: 2007-2014.

As the key result, this article presents the idea of a cognitive locus of shared interpretations (or "common understanding") of the project focus (Okhuysen and Bechky 2009; Seidel and O'Mahony 2014; Vuori and Huy 2015). This locus allows the creation of knowledge as a group during geographical dispersion. This finding demonstrates the importance of acknowledging knowledge as individually interpreted when studying knowledge creation processes through repeated geographical dispersion at the level of groups and its members. Furthermore, three types of cognitive loci that evolve in particular patterns of geographical co-presence and dispersion are identified. The cognitive loci and patterns of geographical co-presence and dispersion are related to the outcomes of the projects and the continuation of knowledge creation beyond project periods. The article proceeds with a literature review (Chapter 2) and presents materials and methods (Chapter 3) and detailed results (Chapter 4). The final section discusses the conclusions (Chapter 5).

Knowledge creation in repeatedly geographically dispersed groups

Creating knowledge happens differently during co-presence and geographical dispersion. Comparative empirical studies show that co-present groups outperform geographically dispersed groups (Hinds and Mortensen 2005; Staples and Webster 2008; Carmel et al. 2010). Geographical dispersion affects team performance negatively in 71% of 46 empirical articles published in the 21st century, being the most problematic form of dispersion for knowledge creation (Nguyen-Duc et al. 2015). In this article, dispersion is geographical and occurs when travel or technology is needed for interaction. Other forms of dispersion include temporal dispersion of members into different time zones (Hoegl et al. 2007; O'Leary and Cummings 2007), dispersion of work (i.e. tasks and practices), cultural dispersion (i.e. cultural backgrounds) and organisational dispersion (i.e. affiliations of group members) (Nguyen-Duc et al. 2015).

Nguyen-Duc et al. (2015) summarise the impact of these five common forms of dispersion on coordination, outcomes and performance of project groups. Their analysis shows that geographical dispersion poses many challenges. Geographically dispersed groups are difficult to coordinate due to misunderstandings, communication challenges and delayed reactions to problems (Hinds and Mortensen 2005; Staples and Webster 2008; Colazo 2014). Finishing tasks takes more time in geographically dispersed groups than in co-located groups, mainly because of the larger number of participants involved in distributed networks (Nguyen-Duc et al. 2015). The quality of results is also worse in geographically dispersed groups than in geographically co-located groups – at least in the software field (Nguyen-Duc et al. 2015). Distributed work includes uncertainty that requires coping strategies, such as extensive emailing, travelling and working during unsocial hours. These coping strategies

evoke stress (Nurmi 2011). For such reasons, the preference for forming local project groups is strong and has even led to locally specialised branches of firms (Boh et al. 2007; Balland et al. 2013). In short-term projects, collaboration is more likely beneficial to co-present partners, whereas longer-term projects can succeed in dispersed settings (Broström 2010).

However, geographically dispersed groups exist when key experts are needed for creating strategically important knowledge. Such aims require the "best" instead of the "nearest" knowledge (Maskell 2014). This is also the case in this article: Finland Distinguished Professors are globally acknowledged to be top professors. Successful geographically dispersed groups have an engaged manager, spontaneous communication, trust, effective organising of knowledge, and "linchpin developers" who connect people in different locations (Hinds and Mortensen 2005; Daim et al. 2012; Iorio and Taylor 2015). If group work is coordinated well, the challenges of geographical dispersion can be overcome (Hoegl et al. 2007; Shaw and Kennepohl 2013). Dispersion might even become an opportunity for knowledge creation. One such example is the benefits of the circulation of mobile researchers. Visiting researchers often leave their temporary host groups with wider networks that sustain collaboration in dispersion. These "diaspora networks" also allow new contacts with home country colleagues and increase the number of published articles abroad and the quality of published articles after return (Baruffaldi and Landoni 2012; Jonkers and Cruz-Castro 2013). Therefore, circulation supports knowledge creation in both co-present groups and dispersed networks (Jöns 2009).

Knowledge creation and transfer

Individuals and groups are the principal agents of knowledge creation processes (Faulconbridge 2014; Rutten 2014). The organisation provides the socio-cultural environment

and focus for the process of knowledge creation, such as goals, community, equipment, financial support, etc. The process view is based on an ontology of knowledge as constantly evolving, without a formal start or end that projects technically hold (Langley et al. 2013). The term "creation" means the "*process* of bringing something into existence" (Oxford Dictionary 2017). Such knowledge creation requires interaction between agents (constructionist view) that they interpret individually (cognitive view). This approach to knowledge is called constructionist-cognitive (Hautala 2015). Accordingly, knowledge is defined as an interpreted and "justified true belief" that is constantly becoming, or being created further by individuals and groups (Plato 1977; Nonaka and Takeuchi 1995). All knowledge has a degree of tacitness (Howells 2012). Tacit knowledge is embodied in skills, interpretations and practices, which makes it difficult to express and share. Its counterpart, explicit knowledge, can be codified into a text or mathematical model (Nonaka and Takeuchi 1995). In the view of this article, knowledge exists in a tacit-explicit continuum: the two are dimensions of the same knowledge entity (Polanyi 1966).

In general, rather than individuals and groups, economic geographers focus especially on organisations (firms), but also communities and networks, when studying knowledge creation (Hassink and Klaerding 2012; Rutten 2016). These basic units, as well as methods of empirical research, reflect the understanding of knowledge that has been adopted. Three such understandings are common in economic geography (Hautala and Höyssä 2017). The first is a rational understanding of knowledge as an object that is possessed by a firm and thus can exist independent of individuals (Ibert 2007). These studies operationalise knowledge into distinct taxonomies (Tsoukas 1996), such as tacit and explicit, and analyse them through quantitative data and methods. The second is a constructionist understanding of knowledge that stresses the role of interaction and practices in communities (or networks or organisations) that construct knowledge (Ibert 2007). These studies are usually based on

qualitative data and methods. The third is a mix of rational and constructionist understandings. For example, the concepts based on a constructionist understanding of knowledge (e.g. communities of practice, tacit knowledge) are acknowledged, but for the empirical study, they are analysed using quantitative methods.

However, in order to understand knowledge creation processes through repeated geographical dispersion in groups, empirical research that focuses on project groups and their members is needed (Faulconbridge 2014; Rutten 2014; Rutten 2016). For such a starting point, economic geographies of knowledge creation benefit from developing a constructionist-cognitive understanding of knowledge that recognises knowledge as being individually interpreted. Such a view is currently underdeveloped in rational knowledge-based research and its focus on organisations. This is also the case in the constructionist understanding of knowledge that is based on communities and guides research to focus empirically on rather wide networks, ecologies of actors (e.g. Grabher 2002) and communities of practice (Wenger 1998). In constructionist-cognitive view, one group hosts various interpretations of the same original body of knowledge. Interpreting interaction involves comparing and connecting the message with the existing knowledge base of the individual (Meusburger 2009). Therefore, interpretation makes a difference between information and knowledge. If the message cannot be interpreted and connected into the knowledge base of the individual, it is information – not knowledge.

Creating knowledge in repeatedly geographically dispersed groups requires the mobility of knowledge over distance either through a mobile individual or messages. Economic geographers often discuss such mobility using the term “knowledge transfer” (e.g. Bathelt and Henn 2014). Regarding terminology, the term “transfer” differs from “creation”. To transfer means to “move from one place to another” (Oxford Dictionary, 2017), without any change in meaning from the sender to receiver of the message (Bechky 2003).

Transferring means copying, exchanging, assimilating or handing over the possession of knowledge (Gavroglu et al. 2008; Mattes 2012). When considered through a rational understanding of knowledge, the FiDiPro Professors and mobile researchers in general can transfer knowledge into an "asset" of the receiving work location (brain gain in co-presence), while the knowledge they "carried" is lost from the previous work location (brain drain in dispersion) (Morano-Foadi 2005; Kerr 2008). However, in reality, personal adjustment, feelings, new colleagues, organisational support, etc., have an effect on context-specific knowledge creation processes. Even the FiDiPro Professors may fail in creating critical knowledge in new research groups and organisations abroad, even if they are moving within the same research community that shares the key skills and practices of knowledge creation internationally. Indeed, changes of knowledge through geographical mobility result often in distortions that diminish the value of that knowledge (Maskell 2014).

This is acknowledged in the knowledge creation approach of this article, where (re-)interpretation, or transformation (Bechky 2003), rather than transfer, is the key mechanism of mobility. Therefore, entering a new organisation abroad requires the re-interpretation of existing knowledge and skills in a novel context – often critically different to the previous one. All acts of sharing knowledge with new colleagues also change knowledge through re-interpretation. This is also the case for mobile knowledge objects such as research articles that readers re-interpret in new contexts. Therefore, in this view, only information can transfer "as it is" – not knowledge. As a conclusion, the knowledge creation approach from the constructionist-cognitive understanding of knowledge sets justified premises for studying knowledge creation processes through repeated geographical dispersion. The adopted understanding of knowledge guided the selection of the concepts applied in the empirical analysis of this article. These concepts are presented next.

Cognitive locus of knowledge creation in repeatedly dispersed groups

The difficulty of knowledge transfer (as it is) has been identified in several disciplines (Bechky 2003). Sociolinguistics starts from interaction that requires language. Words have multiple meanings that are interpreted within a particular context of, for instance, discipline, project and situation (Duranti and Goodwin 1992). Similarly, semiotics denotes that signs hold multiple meanings (Eco 1976). Employees who move between several locations when creating knowledge in one project discuss, apply and justify this knowledge in different contexts. In geographically dispersed groups, the contexts of interpreting interaction, or messages consisting of words and signs, may vary dramatically. Therefore, one message may be interpreted very differently in the group, which easily leads to misunderstandings, communication problems, and working towards unshared goals – the list of issues that makes geographically dispersed groups difficult to coordinate (Hinds and Mortensen 2005; Staples and Webster 2008; Carmel et al. 2010).

A shared context moderates conflicts that are easily developed between geographically dispersed group members (Hinds and Mortensen 2005), and increases the motivation and ability of managers to share knowledge between geographically distant locations (Nell et al. 2016). Therefore, it is crucial for geographically dispersed group members to share a common understanding of the key focus of the project or task they are working on. In social psychology, the importance of shared understanding is studied, for example, through group cognitive models concerning key elements of the task and environment of working (Mohammed et al. 2010). More familiar in economic geographical research is the literature on communities of practice, where shared understanding has been studied as sense-making. Members of communities make sense of (i.e. interpret) interaction

by forming and using “modes of identification” to reflect their relation to and role in a particular community (Wenger 2010, p. 184).

This article focuses on analysing the individual interpretations of the project focus. If and when they are shared, these interpretations form a “cognitive locus”, or trust-based “common understanding” for the project group (Okhuysen and Bechky 2009; Seidel and O’Mahony 2014; Vuori and Huy 2015). A locus forms out of shared key concepts the group members use to understand and describe the focus of their projects. In complex projects, the locus is formed around systems thinking, where change in one concept influences several concepts in the system simultaneously (Safayeni et al. 2005). The cognitive locus also requires the acknowledgement of emotions, such as anxiety. Shared emotions have been found to lead into cycles of behaviour that might benefit or harm innovation processes (Vuori and Huy 2015). Bechky (2003) applies the term “locus” to describe the conceptual or physical anchor of practices for different organisational sub-groups that are used for interpreting their knowledge-creating interaction.

In economic geography, the cognitive dimension related to knowledge concerns clusters, industries and organisations. Clusters include the cognitive dimension of a shared field and cognitive frames (Maskell 2014). Industries are cognitive systems (Camuffo and Grandinetti 2011) with their specific knowledge bases (Asheim 2007). Another vivid discussion exists around the proximity literature (see recent developments, e.g. Huber 2012; Hansen 2014; Fitjar et al. 2016). The principal argument is that there are several dimensions of proximity (geographical, cognitive, organisational, etc.) in collaborative knowledge creation (Boschma 2005). Cognitive proximity is the key requirement for distant knowledge transfer between organisations (Bathelt and Henn 2014). The concept of cognitive locus resembles the dimension of cognitive proximity to some extent. However, there are critical differences, which is why the case study groups for the purposes of this article are analysed

through the concept of cognitive locus. Whereas cognitive proximity measures the *similarity* of the knowledge bases of actors (usually firms; Hautala 2011), cognitive locus is the *shared conceptual focus* of the group members. This difference is simplified in Figure 1. As a result, locus is a dynamic and changing cognitive space where members attach, detach and re-interpret concepts during the knowledge creation process. In contrast, cognitive proximity is very seldom considered as a process (Hautala 2011) and is rather based on rational understanding of knowledge. The dimensions of proximity are most often measured between organisations and using quantitative methods – although more recent qualitative examples include applications at the levels of individuals and projects (e.g. Hansen 2014). In terms of cognitive proximity, all of the empirical project group members of this article shared an analytical knowledge base typical of scientists (Laestadius 1998). However, a much more focused cognitive locus was required in order for them to create knowledge together.

Figure 1. Cognitive proximity (left) is measured as the similarity of knowledge bases. Cognitive locus (right) means mapping the shared conceptual focus (grey area).

Shared contexts in co-location, co-presence and dispersion

A shared context is crucial for any knowledge creation, but in particular for geographically dispersed groups (Hinds and Mortensen 2005; Wlazlak and Johansson 2014; Nell et al. 2016). Research on shared contexts has concentrated on various aspects such as the common values, language, culture and work practices of groups, organisations and communities (Wenger 1998; Gertler 2003; Nell et al. 2016). Derived from Hautala and Jauhiainen (2014), shared context is here studied through three dimensions; geographical (as co-location and co-presence, Zhao 2003), communicative (as key practices of collaboration) and cognitive (as

cognitive locus). Knowledge creation in repeatedly dispersed groups is characterised by the pattern of sharing geographical context, or working in co-location, and then not sharing this context, or working in dispersion. Temporal co-presence organised at the appropriate time, for instance, during complex tasks in projects, should ensure knowledge creation (Bathelt and Turi 2011). A shared trust-based context requires co-presence to develop, but may be sustained during dispersion (Nilsson and Mattes 2015).

Research by economic geographers on clusters, territorial innovation models and forms of proximity that has already been discussed demonstrates important findings on co-location and co-presence. Knowledge is considered a "location factor" and is determined by the availability of knowledge and partners in a region (Rutten and Boekema 2012, p. 987). Region-specific "institutional dynamics", including practices of regulation and governing, are identified to play a crucial role in the innovation process by territorial innovation models (Moulaert and Sekia 2003, p. 291). All of these findings refer to the importance of the *co-location* of key actors, referred to in economic geography as a cluster. A cluster requires geographical proximity – co-location – of a business, a university and public sector organisations (Martin and Sunley 2003). Since some cognitive locus is needed to ensure fruitful knowledge-creating interaction, the firms in a cluster often belong to a shared industrial field (Porter 1998). In temporal clusters, for instance conferences and trade fairs, the co-location of actors is short-term (Bathelt and Schuldt 2008). In a cluster, co-location evokes co-presence, "being there" of actors (Gertler 2003) that can be organised quickly and often through accidental encounters. This creates the main mechanism of knowledge transfer and creation in a cluster: local buzz. Buzz describes knowledge that flows in the air through the interactions of members (Tallman et al. 2004). The members can share tacit content and the most valuable knowledge face-to-face when they share a field (Huber 2012) – i.e. are in cognitive proximity. Several economic geographers have concluded that merely "being there"

is not enough for knowledge creation (Jones 2007; Müller and Stewart 2016; Gertler 2008), yet there is no clear distinction between moments of co-*location* of actors from their co-*presence* characterised by interaction that is crucial for knowledge creation process. Similarly there has been much less discussion on the unimportance or disadvantages of co-location. Indeed, from the process perspective, even in an environment (cluster) that encourages accidental encounters and knowledge sharing, there are periods without important interactions for knowledge creation. Therefore, research is needed to gain a more nuanced understanding of knowledge creation processes through repeated geographical dispersion (and co-location or co-presence) of groups.

According to Goffman 1963, p. 17), in *co-presence*, individuals experience each other and "sense that they are close enough to be perceived". Therefore, people become "accessible, available, and subject to one another" (Goffman 1963, p. 22), and their presence represents respect and value to others (Strengers 2015). This reciprocal nature is the key of co-presence – a person simultaneously senses others and feels how others sense them (Bulu 2012). All sensory channels (taste, smell, touch, hearing, vision) and the "full range of body idioms" (e.g. gaze and gestures) (Broadhurst and Mason 2014, p. 581) are in use, which makes face-to-face communication embodied (Zhao 2003; Broadhurst and Mason 2014). Seeing the practice of a distant colleague was crucial for a research group to learn to achieve high-level results in a laboratory measurement (Collins 2001). In this article, co-location means that group members are working in the same city and university department, but they do not consider each other accessible, available and present for knowledge-creating interaction, which they do when they are co-present.

Materials and methods

These case studies analyse four FiDiPro-project groups in the fields of technology (Data, Lab and Satellite) and science (Science) in two Finnish universities. A case study is a suitable strategy to study processes in their contexts (Yin 2014). This study focuses on group members, which allows an analysis of the varying understandings in the groups (Perren and Ram 2004). When carefully done, the cross-case setting allows some generalisation (Langley 1999). It also allows theory to be built through logics of replication where each case study is one "analytic unit" (Eisenhardt and Graebner 2007, p. 25). In this article, each case study group is one "analytic unit" and each group was analysed as such. However, the results concerning two of the groups were similar: both formed a cognitive locus with similar characteristics and also shared a similar pattern of geographical co-presence and dispersion. Therefore, these two groups are discussed under the same sub-section. This helps to demonstrate variety within this particular cognitive locus and pattern of geographical co-presence and dispersion. Building theory in this article proceeded through iterative cycles of inductively analysing the data and adjusting the theoretical background to find the best concepts to answer the research question. Another side of the cycle included testing the adjusted theoretical background through the case studies (Eisenhardt and Graebner 2007). As a result, the research findings were summarised into three types of locus and their related patterns of co-location and dispersion.

The main data is shown in Table 1. The supportive data includes a database of the project publications, project proposals, official project descriptions, and web pages of the Professors, the projects, the FiDiPro-programme, and the host university departments. The knowledge creation processes of groups were followed "here", including intensive stages with observation, site-visits, and interviews, and "now" as the projects progressed without knowing their outcomes beforehand. The names of the universities, the exact research fields, the projects, or individuals will not be revealed. Two intensive stages were conducted during

their 4-5 year funding period with about one year in between each, and one stage one to two years after the end of the project period.

1. Beginning of projects (2007): First, three project members were interviewed. These were the FiDiPro-professor (P), the senior researcher (PhD or advanced PhD-student) (R2) and the junior researcher, usually an early stage PhD-student (R1).
2. 2007-2008: Observation of key events, like workshops and meetings. Visits and discussion with the group members. P, R1, and R2 wrote weekly diary reports about the most important events and whether they disturbed or helped the work.
3. (About) a year after the beginning (2008): Interviews of P, R1, and R2.
4. After the projects 2012-2013: Interviews of P, R1, and R2 (when possible). New researcher(s) of the FiDiPro-topic working in the Finnish university were interviewed: R3 (a PhD-student who worked in the FiDiPro-project after 2008), and R4 (new Lab group leader).

Table 1.

The data is analysed using two methods. Firstly, a content analysis of the diaries and interviews were conducted. The main content of the text was identified by summarizing the text with regards to its context (FiDiPro-projects) by identifying the main concepts, categories, and patterns (Elo et al. 2014). Supportive data was applied to understand the context of the projects beyond the interpretations of the members. Secondly, the method of concept mapping was applied to analyse the cognitive locus. Concept mapping reveals similarities and differences of group members' interpretations of their projects and the development of the projects. It aims to answer a key question by demonstrating hierarchical concepts and their relationships (Davies 2011). Building these maps includes three main stages. First, individual maps were constructed depending on the times a member was

interviewed (Table 1). In general, two or three maps were constructed for P, R1, and R2, and one for R3 and R4. The method included four main stages (Eden 2004; McComb 2007):

1. Identifying the key question: "What is the focus of the FiDiPro-project?". This topic was discussed in all interviews, allowing comparison of several members' views at different time points.
2. Identifying and organising content. The relevant extracts of the interviews discussing the focus of the FiDiPro project were selected and treated as the corpus for building the maps. From these extracts, key concepts and statements were summarised into a table for each group (Table 2). This table included a column for each individual and three categories of rows representing the three time points. For example, the following extract is from an interview after the FiDiPro project ended:

   > *"the main goal was to prepare a better description of the (X). And in the beginning we realized that a certain class of approaches that we wanted to apply were too restrictive. And I think already this was a very very nice achievement to show that something is not so good within a certain framework. And this we showed that it requires an extensional framework. And then we built this extension."*

   This extract can be summarised using the following key concepts and statements: "better description of the (X)", "(restrictive) class of approaches", "(building) extensional framework". Therefore, these key concepts and statements were placed in the third category of rows (after projects) (Table 2). When going through the interviews with other individuals of the same group, similar key concepts and statements were placed into the same rows. These are considered as shared concepts at a particular time. When proceeding from this table towards the cognitive maps, the key concepts and statements were categorised into two hierarchical levels: first-level

concepts formed the backbone for answering the key question “What is the focus of the FiDiPro project?” In the example in Table 2, all of the concepts are first-level concepts. Second-level concepts explain or further define the first-level concepts, for instance, giving details of the methods used for building the “extensional framework”.

3. Mapping content: First level concepts were placed at the center of the map, surrounded by second level concepts. Nearly all interviewees discussed the key question along a theme of an “inquiry” (what is the gap in the current research) and a “solution” (what will the project offer to advance this problem). These two themes were organized on opposite sides of the concept map (Figure 2).
4. Links were formed between concepts through expressions such as “belongs to”, “for this we need” etc., or by following the logics of the interviewee. For instance, in the example extract (see stage 2), it is clear that the interviewee links their realisation of “(restrictive) class of approaches” to their work of “(building) extensional framework”.

The individual maps were summarised into group maps representing three time points: beginning, after a year and after the project. Each concept included member codes (Figure 2). The group maps were summarised in Figures 2-4 (see Sections 4.1-4.3). These figures include only concepts and links that are shared by at least two group members. Three basic features in the figures were used as the background for answering the research question and identifying key differences between the groups.

1. Shared concept space of the group members and its change at three time points (e.g. the number of shared concepts and links) (Figures 3-5).
2. Loops formed by shared concepts and links (Figures 3-4: circles). In a loop, the concepts form an iterative cycle. For instance, an inquiry loop includes a research gap

that several members identify and describe with similar concepts. A solution loop forms out of a theory, analysis or other solution for the inquiry that is described similarly by several members. However, what makes such a system a loop is that the members repeatedly return to the inquiry, formulate a solution, return to develop the inquiry and formulate a better solution (Figure 3, Science group). In the example extract used above (see stage 2 of the four main stages) the elements of the loop exist. Whereas the "better description of the (X)" and "(restrictive) class of approaches" were concepts of inquiry, "(building) extensional framework" was a concept of solution. These are linked, and through them the inquiry and solution are also linked. When completed with other project descriptions of the group, their diary entries and observation of meetings, it was considered a result that they returned to use such loops repeatedly to create knowledge further. It is also possible that only an inquiry loop forms (Figure 4, Lab group), which means that several members share an understanding of the key gap in research. However, the connection of the gap to developing the solution is not shared in their project descriptions.

3. Tails formed of further (second order) concepts that are linked to a key concept. For instance, some new members with new research foci could add new concepts to the cognitive locus. As a result, the group members shared a wider cognitive locus and in particular a wider understanding of certain aspects of the project focus.

Table 2

Figure 2. Concept mapping into group maps.

Three cognitive loci and their patterns of geographical dispersion and co-location

Comparisons between the project outcomes were limited because their funding periods (Data four years, others five years) and aims (scientific/practical) differed. The Science and Satellite groups focused on scientific aspects and the others on the practical outcomes of creating a database (Data), and a laboratory and training (Lab). Therefore, the combination of selected measures was used to form three basic groupings of outcomes: very good, good and relatively good. These measures included publications, reflections of the members about their project and a continuation of knowledge creation beyond the project period through further funding and collaboration (Table 3). This funding allows continuing research related to the original project topic in the host university, and is directed to the Professor. Collaboration is considered tight when a Professor continues leading a project group with some original FiDiPro-members in the Finnish host university and visits there regularly. Interviewees reported examples of how the collaboration continued. In loose collaborations the Professor's visits were occasional and irregular. The interviewees had often moved to new groups and the collaborations produced very little further publications with the original FiDiPro group.

##Table 3.

The Science group represented a group with very good outcomes. They published the largest number of articles that were also of a high level and often cited. The members were satisfied with the project. Knowledge creation on this topic and in collaboration between several original group members continued after the projects. The Professor received competitive funding for at least for six more years, and this was the only group who recruited further members after project period (altogether 18 members in 2014). R2 also built a parallel group in the host university. Therefore, their collaboration stayed tight. Moreover, altogether

16 of the 18 members have continued publishing articles about the project topic and referred to the FiDiPro articles after their project work period. The Science group was mainly formed by bringing young foreign researchers into Finland. Only the first two members were recruited from the host university. In comparison, the percentage of the members with previous affiliation to the host university in other groups was larger (at least 50 %).

The outcomes of the Lab and Satellite were good. Several cited articles were published, and some of them in high level journals. Both projects also left "a legacy" for the Finnish host university so that nowadays there is a platform for further knowledge creation. The legacy of the Lab group is a laboratory and researchers educated to use the laboratory. The legacy of the Satellite group is, accordingly, a Finland-based "satellite group" that creates knowledge in parallel to the professor's home university research group abroad (see Section 4.2). However, the outcomes of the Lab and Satellite groups were also different in terms of member's reflections, continued funding, and collaboration (Table 3). A (Satellite) group, as a legacy, supported tight collaboration after project, but a laboratory is a material platform and does not require tight collaboration with the original FiDiPro-group.

The Data group reached relatively good outcomes. Due to their practical aim, the publication activity was not as strong as in other projects. Moreover, the continuity of knowledge creation beyond the project period was not as clear as in other groups. Most importantly, the project was not continued with further funding and the database created in this project was moved abroad due to little local interest (R3 2012; e-mail discussion in 2014 with an industry employee who participated in building the database). Therefore, there were no clear legacies left in the host university to support tight collaboration.

Collaboration practices were created during the first period of co-presence and modified later following new recruitments. Only the Science group sustained key practices from the beginning to beyond the end of the project. Usually, the set of practices differed

during periods of co-presence and dispersion and during the project timeline (first year, after the first year and after the project) (Table 4). Co-presence included face-to-face communication and intense meetings. When dispersed, e-mail was used for specific questions and Skype when needed. However, these practices were often not enough to support their specialized knowledge creation. Therefore, local key researchers steered the Science and Data groups during the absence of Professors, while the Lab and Satellite Professors brought some group members to work in their home universities.

##Table 4.

Strong cognitive locus and frequent long periods of co-presence: Creating knowledge during dispersion and beyond the project

Strong cognitive locus: Science operates on basic research. Their aim was to create a new definition for a central concept. Although this was not reached, a new "open" theory developed step-by-step was created in the field dominated by "closed" theories. The Professor called this a breakthrough. An important explanation of the very good outcomes is related to their strong cognitive locus that evolved through long, regular periods of high quality co-presence. During dispersion, the strong cognitive locus was sustained and used to solve problems independently. The strong cognitive locus was characterized by interacting loops of shared thinking and a link combining inquiry and solution (Figure 3). This is called systems thinking where change in one concept influences several concepts in the system simultaneously (Safayeni et al. 2005). Loops enable an iterative cycle of returning to the enquiry, approaching the key question from different angles and developing the solution forward accordingly. This iterative cycle was also enhanced by their theory that was possible to develop step-by-step. The key question steered their group work during periods of

geographical dispersion: How to build a *reliable theory* concerning a *particular concept*? They shared this key question and its *three key concepts* throughout the project and after. The first loop of solution was developed in a year and it showed the first steps of their open theory. These are the *two* shared *key concepts*: *functional A* and *novel results*. After the project, the loop of solution evolved to include an extensional framework – the open theory. A link between the solution and the inquiry was also created: the functional A was proved important for defining the central concept, which was the original aim of the project.

Figure 3. Strong cognitive locus and frequent long periods of co-presence.

Frequent and long periods of co-presence: Compared to other FiDiPro-professors, the Science Professor followed the most regular rhythm of co-presence and dispersion and also spent the longest time periods in Finland – about 5 months per year. The co-presence in this group was of high quality including sustained practices (Table 4), frequent and easy f2f-communication, commitment, trust and an open atmosphere. The most intensive progress took place during co-presence. During dispersion the researchers confronted several problems, but were able to solve them independently. The Professor was experienced in working abroad in various universities throughout his career and had developed an international practice of moving between groups, projects and universities:

> *This is exactly my perception of how my achievements were promoted to a new level. Every time I was moving to some other place. And that's why I think, I like very much this arrangement of spending half a year here, half a year in Finland, because every travel like that. I have to make a summary of what has happened during the previous period, what are the projects of the new periods, […] one box closed, another box opened. (Science P 2012)*

Partial cognitive locus and bipolar co-presence: Struggle of dispersion but legacies for knowledge creation beyond projects

Partial cognitive locus: Lab aimed at enhancing the quality of the research of their topic in the host department by building a new laboratory and education programme. Satellite's goal was to develop technological applications, related theory, and methods. These groups formed a partial cognitive locus, where shared concepts and links between them existed and increased during and even after the project (Figure 4). However, there are major differences in how the members interpreted these concepts related to the aim of their projects and which concepts they emphasized. Therefore, at times, members were progressing in different (not shared) directions that created some of the problems they faced in the early phase. For instance, there were different understandings about the required budget, the role of research in comparison to education, the content of the research task, and the steps to needed for progress in the project. This locus is called partial since it lacks interactive and dynamic loops. In general, the loops were lacking when the projects were described and understood through the researcher's own focus area and concepts, which did not connect their understandings of the project as a whole. Therefore, the wider project descriptions are not shared between the members and there was no shared conceptual space for links required of for loops to form, either. However, one shared loop was formed by the Lab concerning their question about finding ways to incorporate a new field into the host university.

The legacies are represented in the cognitive locus by "tails" formed after the projects in both groups (Figure 4). This means a more complex individual understanding evolved about key concepts that enabled further development without the project organisation. However, these understandings are not a straight forward continuation of the FiDiPro topic. They represent the skills and interest of local members and other actors. For instance, the lab has become a part of a chain of local laboratories that "cluster" the actors of this research topic.

Figure 4. Partial cognitive locus.

Bipolar co-presence: These groups applied both the host and home university of the Professor as locations of co-presence. The Lab Professor mainly visited Finland rather quickly, altogether about 1-3 months per year. The researchers from Finland were trained at the Professor's home university to use the laboratory. These researchers formed the core of a new research group working in the lab in Finland. The Satellite Professor visited Finland for longer periods of time, altogether about 2-4 months per year. However, his visits often took place during the Finnish vacation periods such as the summer months, when the university was nearly devoid of students, events and much of the staff. In addition, the Satellite researchers visited the Professor's home university abroad; the visits lasted from a few weeks to several months at a time, and the Professor also brought his home group of students for a stay of several months to the Finnish university.

The Lab and Satellite groups struggled in the beginning since they lacked resources – funding (Lab) or "the right" employees (Satellite). This struggle culminated during the dispersion (Figure 4: period of disturbance of Lab), when even the small steps taken in the process of knowledge creation seemed to disappear. In other words, parts of the cognitive locus were weakened. Despite building a bipolar co-presence, the projects were closely connected to their Finnish "home base". Complementing resources was mostly only possible in Finland and in the host university, for instance, through funding schemes and local actors. Moreover, these possibilities were bound to particular dates such as funding proposal deadlines and the presence of the "right people". These groups did not always have an active counterpart in the host university to continue knowledge creation, or the practices for creating knowledge during dispersion were lacking. Working on the project at a dislocation from the host university was difficult:

> *This week has not been very productive (…). I returned to (Professor's home university) and, therefore, most of the (Fidipro-related) work was left in*

> *(Finland). Being in two places is very contradictory. It is difficult to react both to my own research work and this FiDiPro-project equally, or know how to differentiate them. Here (Professor's home university) […] my thoughts are mostly in my own research and less in the FiDiPro. On the other hand, my doings in the project are connected to (Professor's) mobility. My action is a reaction to (Professor's) wishes and requests. Now (Professor) is still in Finland and I am here, so it is quiet. This is probably the biggest factor making my work difficult now. (Lab R2 2007)*

An evaluation of the FiDiPro-programme notes that the recruitment of researchers was a crucial challenge for the success of the projects (Wennberg et al. 2014). Suitable local student recruits were difficult to find during vacation periods - there was no co-presence of the right people. The difficulties described above, made the Professors' stays in Finland less productive, and were used as an argument to work from the home university.

Cognitive dispersion in irregular and short-term co-location: Struggling during co-location and knowledge creation that does not continue beyond project

Cognitive dispersion – without a locus: The Data group performed technical research and aimed to create a database. The interpretations of project's focus by the first members of the Data group were dispersed. No shared loops or concepts to link the solutions and inquiries existed. The interpretations of the project focus were quite static and little change exists between the three time points (figure 5: 5 +/- signs compared to 2-3 in other groups). The project started from a solution (Database) instead of an inquiry. In the beginning stage, the two key concepts were shared by the three members; however, the views about their application were different. During the first year, R1, and R2 left the project. R1 and R2 focused on delivering particular tasks for the project, but were not motivated to widen the interpretation of the focus. Later, due to new researchers joining the group, the interpretation of the project's focus developed (Figure 5: After project). For instance, the concept

"multidisciplinary" was developed into a central role in the inquiry, and the conceptual tails produced by the first researchers were abandoned. R3 created novel findings and graduated as a PhD. Nevertheless, attachment to the topic was not sustained beyond the project. R3 did not continue at the Finnish university, in the Professor's research group or with the topic.

Figure 5. Cognitive dispersion.

Co-presence based on visits: Compared to other FiDiPro-Professors, the Data Professor was least present in Finland, especially during the first year. Short visits were not balanced by bipolar co-presence. Researchers did not know well in advance when the Professor would come or leave. Some of the co-present periods were described as rather "co-locational" by the researchers, as the Professor focused on building contacts in industrial organisations. Sometimes the researchers had to seek help via e-mail from foreign experts they did not know personally, even when the Professor was in Finland. At times, the researchers were worried about discussing face-to-face with the Professor about the slow progress or bad news. Therefore, some periods of co-location did not advance the project work.

Dispersion, anxiety, and geographies of commitment

There exist two key explanations of how the development of a cognitive locus is related to the repeated pattern of co-presence, co-location and dispersion. First, *dispersion creates anxiety*. In general, 65 % of the diary reports describing progress in knowledge creation were written during co-presence, while 82 % of the disturbances were reported during dispersion (Figure 6). In reality, reporting disturbance was more common, since their descriptions were also included in the progress reports (especially Data reports).

Figure 6. Diary reports during co-presence and dispersion.

The tone of reporting disturbance differed during co-presence and dispersion. During co-presence, nearly all the groups enjoyed instant emotional communication that built excitement, trust, and a calm atmosphere when problems occurred. During co-presence, the researchers reported problems in a short and neutral form, and often found something beneficial to have resulted from the problem:

> *The new application did not essentially improve […] This is a good motivation for our next project.* (Science R2 2007)

> *(Professor) appeared this morning to the project lab […] We discussed a little about our example problem […] I got my hands on it on Thursday.* (Data R2 2007)

> *Today (we) had a meeting […] This money will not provide us really anything to the lab […] (host) Professor told us about another possibility. […] (FiDiPro) Professor will meet (X) […] to present project's importance as well as possible. With this funding we could start building the lab and really start.* (Lab R2 2007)

> *I got a good idea on Tuesday that I finally thought to take from planning to practice. […] I knew to tell (Professor) about the idea […] This blackboard + pencil method […] feels a little weird because I shun presenting myself, but I think I will get used to it.* (Satellite R2 2007)

During dispersion, problems were reported with an anxious tone and usually without a solution, or by describing a solution with a hesitating tone. Science R2 had a series of setbacks in months 5-7 (Figure 3). There was a power failure, the programme did not work and the code repeatedly collapsed. He expected problems and so hesitated about how to proceed. Finally, R2 realized the problem was caused by his own mistake:

> *I probably have to consider […].*
>
> *I should calculate it all again and it takes time.*
>
> *I felt myself stupid […] How did I make such simple mistakes?*

> *Of course, I did not do this completely frictionless because at first I did not understand to change (name).*
>
> (Series of diary reports by R2 in 2007)

Data and Satellite R1s report similarly:

> *Not much has happened […] I discussed with (host) Professor about future […] and told about the insecurity in my heart about the (Data) project*. (Data R1 2007)
>
> *Mammoth rolled a little forward, but new problems go far. We ask for help here and there and see what happens.* (Data R1 2007)
>
> *Ahhhh!! […] I have no more left time to do my own work and research!!! […] I am really close to get mad!!!* (Satellite R1 2008)

The second explanation of how the development of a cognitive locus is related to the repeated pattern of co-presence, co-location and dispersion, is called *geography of commitment*. The presence of a body represents respect and value (Strengers 2015). The researchers evaluated the Professors commitment to the project and group through the Professors' geographical mobility (co-presence in Finland), and the time and effort they allocated for the FiDiPro project. This can be demonstrated by the percentage of the FiDiPro publications of all the Professors' publications during the project period; these varied from 80 % (Science), 54 % (Lab), 34 % (Data) to 23 % (Satellite). One Professor was considered to have been disappointed in the Finnish group because he had started new projects elsewhere. Another Professor was described as very busy and several members were disappointed with the collaboration. The practices of co-presence and co-location represent different geographies of commitment. Plain co-location can even be harmful for the project's progress. At times of low quality co-presence (i.e. co-location), researchers described the Professors as "unpredictable", "very busy", "sometimes does not have time to answer my e-mails". All the interviewed researchers considered the Professors committed if their stays in Finland were frequent, long enough, well anticipated beforehand, and if the Professor was present for the group when in Finland. The length of time spent together with the Professor is visible in the reflections of group members about their projects.

Conclusions

This article contributes to economic geographies of knowledge creation by providing a rich empirical analysis of knowledge creation processes through a repeated pattern of geographical dispersion and co-presence of (project) group members. The key contribution is twofold. First, the article steps beyond the moment bias and develops further the emerging discussion and related empirical research in economic geography on processes of knowledge creation from spatial perspectives (e.g. Bathelt and Cohendet 2014; Cole and Barberá-Tomás 2014; Vallance 2014; Ibert and Müller 2015; Hautala and Jauhiainen 2014; Ibert et al. 2015). In general, few researchers have followed projects from their starting point to beyond their completion (Müller-Seitz and Sydow 2011; Hellström et al. 2013; Maniak and Midler 2014). Despite the increasing mobility of experts and the number of international groups, there is very little empirical research – even outside economic geography – which considers the repeated pattern of co-presence and dispersion in the knowledge creation processes of groups and individuals. This article presents a qualitative case study of four project research groups and their knowledge creation processes, where empirical materials have been collected at three intensive time points: the beginning, after a year and after completion. The project groups were repeatedly geographically dispersed since they were led by eminent foreign professors.

Economic geographical research often considers dispersion as a separate state in knowledge creation (Bathelt and Henn 2014). In reality, periods of co-presence and dispersion interrelate in complex ways. The results of this article support previous findings that stress difficulties in knowledge creation which arise during geographical dispersion (Nguyen-Duc et al. 2015). Dispersion creates anxiety and disturbs progress. However, it is

not impossible to even create breakthroughs in regularly geographically dispersed groups with a strong cognitive locus. This means that the group members share the same interpretations of the project focus. The cognitive locus is used for independent problem-solving during dispersion. Therefore, through a cognitive locus, individual members can create knowledge as a group during geographical dispersion, which is the key answer to the first research question (*How do the groups create knowledge during geographical dispersion?).* Moreover, a strong cognitive locus also allows for the continuation of knowledge creation beyond the project period (see research question 2).

As the key answer to the second research question (*How do co-presence, and patterns of co-presence and dispersion, support knowledge creation during the project and beyond the project period*?), three types of cognitive loci and related patterns of geographical co-presence and dispersion are identified. First, a strong cognitive locus is evolved through long and frequent periods of good quality co-presence. The project resulted in very good outcomes and knowledge creation that the original project members continued after the project. Second, partial cognitive locus developed in two groups with a bipolar co-presence in the professors' homes and host universities. These projects resulted in good outcomes and left legacies at the Finnish universities that support further knowledge creation by original and new researchers. Third, cognitive dispersion was formed through short-term and irregular co-location. The project resulted in relatively good outcomes, but without clear continuity of knowledge creation beyond the project period.

Second, the article contributes to the increasing research in economic geography that has started to analyse knowledge creation from the levels of individuals and groups instead of the more general-level units such as organisations, communities, clusters and regions (e.g. Faulconbridge 2014; Rutten 2014). Such individual-level analysis is nuanced by adopting the constructionist-cognitive understanding of knowledge as being individually interpreted. This,

in turn, enables a cognitive locus to be identified and its meaning for knowledge creation during co-presence and dispersion to be analysed. Moreover, the constructionist-cognitive understanding of knowledge supports the idea that geographical mobility of individuals and messages always includes a re-interpretation of knowledge in the new context, which always changes knowledge. The case studies in this article have demonstrated that even globally distinguished professors cannot continue knowledge creation without challenges when moving internationally to new universities. From this perspective, more attention to using and developing the terminology of mobility of knowledge in economic geography is called for. The commonly used term "transfer" refers to the idea that knowledge can move geographically "as it is", without changing (Bechky 2003). Instead, researchers are encouraged to analyse what exactly happens to knowledge and in knowledge creation processes when knowledge moves from one place to another.

As the third contribution, a more detailed understanding of co-location and co-presence for knowledge creation is presented. This challenges the rather common view in economic geography that considers face-to-face interaction to be nearly always positive for knowledge creation (Bathelt and Turi 2011), and adds empirical detailed evidence about the circumstances in which "distanciated" knowledge creation takes place (Gertler 2008, p. 303). Co-location and co-presence result in different cognitive loci. A strong cognitive locus is created through frequent and long periods of good quality *co-presence*. A good quality of co-presence means instant emotional communication of the "right people" that builds excitement, and calmness when facing problems. Therefore, the mobility of a manager to enter an organisation "at the right time" in relation to other people, ongoing events and phases of the knowledge creation processes represents geographies of commitment. A co-present manager is interpreted as being committed by the members of the group. In addition, it is not only "being there", but also being *where* when being there (Rutten 2016) – the

location of co-presence matters. Projects might have a “home base” organisation and be bound to local or national systems of collecting resources, such as funding application processes and deadlines. This is why the most efficient co-presence for knowledge creation takes place in a particular “home base” organisation. Without a cognitive locus, few possibilities are provided for continuing knowledge creation beyond the end of the project period. In this article, the cognitive dispersion followed the pattern of geographical *co-location* during short visits that could not be well predicted by the group members. In co-location, members work in the same building, city, and project, but their project-related communication often includes partners other than the actual group and they do not feel that the manager or other group members are present for each other. However, similarly to the more nuanced understanding of co-presence built in this article, building a more nuanced understanding of different “degrees” of dispersion is a future research topic that is to be encouraged.

Finally, based on the results on the relations between cognitive locus, pattern of geographical co-presence and dispersion, and continuity of knowledge creation beyond the project period, the following suggested propositions are made. These propositions are simultaneously implications for internationally mobile managers of research groups and, in general, for managing the projects of international research groups. If scientific projects are intended to evolve into longer knowledge creation processes with tight collaboration beyond the project period, the case study groups suggest two possibilities. One possibility is to create a good quality co-presence in the project location through frequent and long visits to it by the project manager. This creates a good platform for a strong cognitive locus and commits the members to continue knowledge creation beyond the projects. A second possibility is to create a good quality but bipolar co-presence both in the project location and the manager’s home organisation, to which the project members are brought for long visits. However, if the

manager stays loose from the practices, culture and organisation of the project location, the project may progress more slowly and it may be difficult to take advantage of the local possibilities (e.g. funding and external collaboration). Nevertheless, such a strategy may result in a partial cognitive locus that is strong enough to build two parallel groups where the members are committed to continue creating knowledge on the topic beyond the project periods. Another strategy is to leave a physical legacy at the project location, such as a laboratory or key equipment, that allows the knowledge creation process to continue after the project independently of collaboration with the former project manager. The final suggested proposition concerns the importance of co-presence. If there are only irregular and short-term visits to the project location, there is a risk of no cognitive locus being created. Cognitive dispersion, in turn, risks the commitment to knowledge creation beyond the project period.

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Captions

Table 1. Main empirical data.

Table 2. Summarising the interview extracts into the key concepts and statements within the groups. Underlined text belongs to a category “solution” in the concept maps and the others to the category “inquiry”.

Table 3. Outcomes of the projects.

Table 4. Key collaboration practices during co-presence and dispersion.

Figure 1. Cognitive proximity (left) is measured as the similarity of knowledge bases. Cognitive locus (right) means mapping the shared conceptual focus (grey area).

Figure 2. Concept mapping into group maps.

Figure 3. Strong cognitive locus and frequent long periods of co-presence.

Figure 4. Partial cognitive locus.

Figure 5. Cognitive dispersion.

Figure 6. Diary reports during co-presence and dispersion.