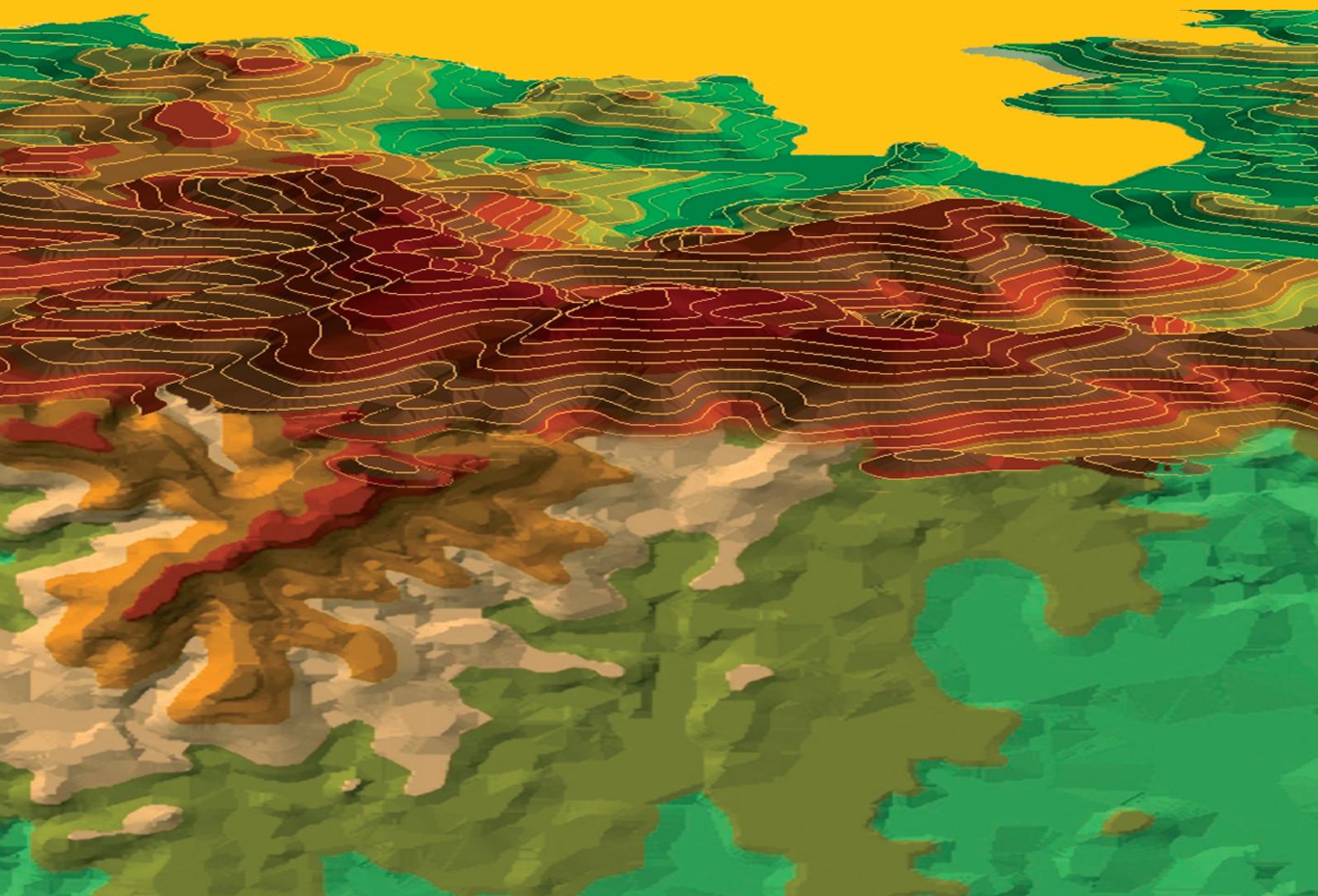


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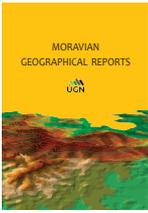
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What about Time-Geography in the post-Covid-19 era?

Pavel KLAPKA ^{a*}, Kajsa ELLEGÅRD ^b, Bohumil FRANTÁL ^c

Abstract

In this year, 2020, the Covid-19 pandemic has imposed new challenges for most human activities. Time-geography is a theoretical approach with great potential for analysing the consequences of the new disease and other disturbances, and this article aims at identifying possible developments of interest for the approach in the post-Covid era. The article addresses challenges that emerge for time-geographic research from the perspective of massive changes in human behaviour, regarding time-space activity patterns, caused by the globally diffusing disease. The implications of the pandemic are discussed with respect to four areas: (i) time-geographic techniques; (ii) activities and rhythms; (iii) activity spaces; and (iv) social issues and perceptions. The time-geographic concepts to be scrutinised are constraints, virtual time space and bundles, and stations and paths. In addition, the article introduces this Special Issue of the Moravian Geographical Reports on ‘Current issues, methods and applications in time-geography’, contributions which for evident reasons were written before the onset of the pandemic.

Key words: time-geography, Covid-19, pandemic, spatial behaviour, time-geographic concepts, future research prospects

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1. Introduction – Time-geography: Evolution and ‘revolution’ in the field?

Time-geography was developed by the Swedish Human Geographer Torsten Hägerstrand (1970, 1974), and the principles, concepts and ontological background of time-geography draw on his earlier works (e.g. Hägerstrand, 1953, in English 1967). His PhD work (1953) was on the chorology of the diffusion of innovations, introducing a processual time dimension and quantitative methods into Human Geography. He also developed methods to more precisely locate objects and places by introducing coordinates (Hägerstrand, 1955), thereby grounding what later evolved as Geographical Information Systems (GIS). This research was inspired by his earlier work on migration and theorizing on migration chains (Hägerstrand, 1950, 1957).

Just like any other field of geographic inquiry, the time-geographic approach has developed through time and new vistas were envisaged (see overviews, outlines, discussions and prospects: Lenntorp, 1976, 1999, 2004; Pred, 1977, 1984; Thrift, 1977; Mårtensson, 1979; Thrift and Pred, 1981; Carlstein, 1982; Hägerstrand, 1982, 1985, 2009; Hallin, 1991;

Gren, 2001; Timmermans et al., 2002; Miller, 2005a; Yu and Shaw, 2007; Couclelis, 2009; Neutens, et al., 2011; Frantál, et al., 2012; Sui, 2012; Dijst, 2019). Two recent monographs by Ellegård (2019a, 2019b) present the development of and state-of-the-art in time-geography in the pre-Covid era. The global Covid-19 pandemic, a ‘revolutionary’ moment for the current status of many disciplines, evokes new challenges and examinations of some recent directions in time-geographic research. The point of departure is the overt and covert changes and adaptations in human behaviour to a new geographical societal context and its anchoring in the time-space.

As emphasised by Poom et al. (2020), the current global crisis is clearly spatial in nature – the virus outbreak, hot spots, mitigation measures, closed borders, quarantines and related societal impacts are all profoundly about distance, separation and space. This has offered geographers opportunities for analyses of the relevant issues through a geographic lens and predestined them to play a significant role in the fight against the pandemic (see Aalberset et al., 2020; Rose-Redwood et al., 2020). Geographical

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knowledge, GIS and spatial analysis have already proved to be important for understanding the pandemic's reach and impacts (see the extensive review by Franch-Pardo, et al., 2020).

Given the present state of knowledge, the ongoing directions of changes in behaviour due to Covid-19 (living strategies, attitudes, perceptions, etc.) of individuals and society are difficult to predict, in the long term as well as the short term. Now, when the vaccine is available, who will get it, when and at what cost? The same applies for any suggested therapeutic remedy. What will be the economic costs and impacts of the pandemic? What will the political costs be? Which population groups will be affected more and which less? Which places will be affected more and which less? These are some questions regarding the uncertainty of the future. The pandemic, its diffusion, consequences and impacts represent distinct spatial and temporal phenomena. The answers for the questions will certainly be different at global, regional and local levels. Thus, we maintain that the post-Covid world will bring about new requirements for time-geographic research, and that some time-geographic concepts and methods will gain increased importance and that some of them, partly forgotten or left aside, will have to be reappraised and rethought once again.

The objectives of this introductory article to this Special Issue of the Moravian Geographical Reports are two-fold. First, it aims at identifying possible developments of interest for the time-geographic approach in the post-Covid era. Second, it will present original articles in the issue, which for evident reasons were written in the pre-Covid era. To fulfil the first objective, this article refers to several extensive and excellent earlier works outlining time-geographic concepts, methods and techniques and the history of the approach, besides reflecting on time-geography in the new situation caused by the pandemic. Conceived as a text pointing to some new avenues in time-geographic research, we attempt to revise the importance and meaning of several time-geographic concepts and to turn attention to some of the time-geographic methods and techniques that we find promising for future research.

We think that it is just the right *time* to open the discussion of further reconsideration of *time-geography*. Thus, this current introductory article strives to do so with modesty, as concluding opinions should get ripe first. The second section discusses the traditions of and the challenges to time-geography in the context of the global pandemic. The third section is on some possible prospects for post-pandemic time-geographic research and what, in our opinion, could become possible new research avenues. The fourth and final section introduces original time-geography inspired articles written by researchers from different parts of the world and from a variety of different research disciplines. They are all written in the pre-Covid era and as such they may serve as points of departure for time-geographic research directions in the post-Covid era.

2. The Covid-19 pandemic: Implications for time-geography?

The new situation, which is the result of the global uncertainty related to the ongoing pandemic, calls for deliberate discussions of future time-geographic directions and relevance. It also brings about new challenges to time-geographic research, its theory and concepts. In this section we put forward some ideas in this respect. We proceed from

overt to more covert aspects of time-geographic research, beginning with a discussion of time-geographic techniques, going on to the issue of routine and random activities, to the role of virtual space, and concluding with social issues and perceptions.

2.1 Time-geographic techniques to understand time-space processes

In the core of time-geography is the assumption of the existence of indivisible individuals in the time-space. The historic existence of any indivisible individual can be recorded as a *path* (or individual path) in the time-space, when a geographical location and time is known for virtually every point along this path. In time-geography, an indivisible individual can be either a human, an animal or a thing, thereby enabling analysis of the relations between humans and other subjects and objects in the environment (Hägerstrand, 1970, 1974, 1976, 2009). The path concept relates to various volumes of time: a moment, a day, a week, a month, a year, a life time, during which the existence of an individual (and for humans, also other dimensions such as her activities, attitudes, perceptions, feelings, etc.) is tracked. From the earliest years of time-geographic research, time-space diaries (also time-space budgets, activity timetables), were usually filled out by individual respondents. They combine traditional time use diaries with spatial movements and locations, and occasionally emotions and health indicators (Ellegård, 2020). While this personal handling of the time use diary is advantageous when one attempts to reveal the subjective bases of human behaviour, then there is a risk that the same subjectivity can bias the precise record of a path in the time-space. This will be discussed further.

The principle of tracking an individual's time-space existence can be suitably used when we face the diffusion of communicable diseases, such as Covid-19. In this respect, we deem the time-geographic technique recording the activities and movements of individuals in time and space very useful when health issues emerge (see, for example: Gao et al., 2020; Oliver et al., 2020). Moreover, the spread of a communicable disease is in fact also a time-geographic problem – that of the diffusion of phenomena in the time-space (as noted above, individuals in time-geographic research are not necessarily human beings). There is then a direct link to Hägerstrand's (1953) innovation diffusion theory. Here, it is not the mere path concept, which is useful. When backtracking an infected person, her physical contacts with others are important. This is nothing more than the well-known time-geographic concepts of encounter, couplings, bundles and groupings, which are partly the result of coupling constraints. The theoretical concept of spatiotemporal proximity (Yuan et al., 2018) gives us a more thorough basis for this issue, together with the notion of random encounters to be estimated (Long, 2018; Yin et al., 2018).

In order to acquire utilisable information on the time-space movements and activities of an infected person, which is a necessary condition for the so-called smart quarantines, reliable methods of backtracking in time and space are needed. As we have hinted above, time-space diaries can be biased by the subjective way they are completed. Today, widely-available communications technologies (such as mobile phones and smart watches with Internet access, Bluetooth and GPS modules) can be used to reconstruct sufficiently the time-space existence of individuals and their contacts and interactions, as long as they carry their communication tools with them. Time-geographic research

has a long experience with such tracking (e.g. Kwan, 2004; Yu, 2006; Shaw et al., 2008; Shoval, 2008; Chen et al., 2011; Šveda and Madajová, 2012, 2015; Shoval et al., 2014; Thulin and Vilhelmson, 2019). There are risks related to tracking technologies and we want to point to the issue of individual data protection, privacy and more general issues of power and human rights. A key concern seems to be that the pandemic has been used to create and legitimise surveillance tools used by governments and technology companies. This is likely to persist beyond the emergency, and the data may be used for purposes such as hyper-targeting by private companies and/or law enforcement by governments, which may be particularly dangerous in less democratic countries (cf. Ellegård, 2019a; Oliver et al., 2020).

2.2 Routines, rhythms and random activities in time space

Individual paths include temporal and spatial dimensions. If only the time coordinate changes, the person finds herself at a 'station'. As space is heterogeneous, the fulfilment of one's needs, desires and duties ('projects') implies also the necessity of spatial movements. Here we come to the term 'mobility' in the time-space (Vilhelmson, 1999). Individual movements can include *routine* activities (everyday activities – see e.g. Ellegård, 1999) and *random* activities. Taking into account the *anchor point theory* (Golledge and Spector, 1978; Couclelis et al., 1987) and the *principle of return* (Lenntorp, 1976; Hägerstrand, 1985; Ellegård and Vilhelmson, 2004), routine activities are logically much more frequent in individual lives than random activities. In this respect, such stations as home, workplace and school are typical anchor points (others have a more or less temporal and ephemeral character). Routine activities have different rhythms (cf. Lefebvre, 2004) – daily, weekly, monthly or yearly. Typical rhythms relate to shorter time periods (daily and weekly rhythms) and include travels to work and school, partly also shopping and some short-term leisure activities. In contrast, many random activities are related to tourism issues.

In time-geography, the concept of *authority constraints* concerns rules, laws and recommendations set up by authorities that people involved in the domain of the authority in question, are expected to follow. For example, Covid-related lockdowns and other measures taken to negotiate and mitigate the impacts of the pandemic, severely interfere with peoples' usual rhythms and the mobility time-space patterns of a substantial part of population (however, there are certain differences among countries in the rigidity of these measures). As a consequence, daily mobility patterns are affected by utilising the possibilities of a home office and telecommuting (cf. for example, Asgari et al., 2019; Thulin et al., 2019), on-line teaching, shopping, etc. Such everyday activities are related to the issue of virtual performance (see Section 2.3).

The attenuation of economic as well as social activities, together with reduced mobility, has brought to the fore some temporary common environmental benefits (e.g. reduction in carbon dioxide emissions, etc.). In contrast, the costs related to environmental issues have been transferred to particular households, as homes have become extensively 'frequented' stations. In this respect, the resource consumption and energy behaviour of households are gaining particular importance (cf. for example: Frederiks et al., 2015; Isaksson and Ellegård, 2015; Palm et al., 2018; Köhler and Trygg, 2019). The aggregate effect of many households using energy-intensive electrical appliances (such as air-

conditioning or space, water heaters and increasingly computers, "smart phones" and servers) concurrently, can contribute to new and higher peak demands on the electricity network. At the same time, the rapid development of renewable energy technologies, varying in time and season, is likely to exacerbate the temporal mismatch between supply and demand, causing many countries to consider how future energy systems might be managed (cf. Suomalainen et al., 2019).

2.3 Physical existence and virtual time-space

The anchor point theory, the principle of return, mobility patterns and rhythms, bring us to the issues of individual and aggregate existence in the time-space, to (daily) *activity time spaces*, and to a space-time fixity of activities (Schwanen et al., 2008; Shen et al., 2015). While paths between anchor points and other stations define activity spaces with regard to the past, the potentially accessible part of the time-space defines possible activity spaces with regard to the future. The time-geographic concept for this phenomenon is the *prism* (Hägerstrand, 1970; Lenntorp, 1976). The shape of a prism is influenced both by the current location of the individual and by her future anchor points, following the principle of return. Another time-geographic core concept that can be related to this vein of thinking is *pocket of local order* (Hägerstrand, 1985; Ellegård and Vilhelmson, 2004). It stands for a place that is organised, scheduled and physically equipped to facilitate the performance of individuals' activities to achieve the goals of their projects.

There are efforts to work with individual prisms in order to reach generalisable results. Yuan et al. (2018) proposed the so-called space-time regions, while Lee and Miller (2019) put forward the concept of the average space-time prism. Liao (2019) defined potential space-time path areas. Moreover, the aggregation of individual activity spaces based on pairs of anchor points (home – workplace, home – school, etc.) are in fact related to the extensively researched issue of functional regions (for the concept: see for example, Klapka and Halás, 2016; for definition and use: see Klapka et al., 2014, 2016). Functional regions are largely based on regular rhythms of movements, such as daily travel-to-work and travel-to-school flows. Under specific circumstances these regions are called daily urban systems, local labour market areas, etc.: we propose the general term *daily spatial systems*, which in fact is very close to the time-geographic concepts of an activity space, pocket of local order and prism. All of these concepts can represent a suitable basis for political decision making, when the question of (smart) spatial lockdowns arises, particularly in an intra-state context. The use of prisms, space-time path areas, functional regions and daily spatial systems for deciding on measures to mitigate diseases could have one significant advantage: it should have the least effect on every day economic and social lives.

Activities in the virtual environment have only started to be discussed and analysed relatively recently (Miller, 2005b; Vilhelmson and Thulin, 2008; Yu and Shaw, 2008; Couclelis, 2009; Thulin and Vilhelmson, 2012). It is closely related to the already-mentioned issue of information and communication technologies (Graham, 1998; Thulin and Vilhelmson, 2005; Schwanen and Kwan, 2008; Shaw and Yu, 2009), which provide one with necessary technological background. The current situation of the ongoing pandemic and its presumed consequences seems to acknowledge and further emphasise the importance of the concept of virtual

space. Such technologies make it possible for people to perform activities that formerly needed transportation to another place, now without moving physically. This brings to the fore the detachment of places (*stations*) from activities (in *projects*) in the form of on-line shopping, on-line teaching, etc. (*bundles* in virtual time space), it can add to the decrease of physical mobility and physical contacts, and it enables one person to restrict their social contacts and activities to a certain extent. When purchases are involved, however, someone else has to transport the good to the customer. Time-geographic diary-based studies of daily life facilitate understanding such consequences of Covid-19, since the time-geographic diary methodology builds on detaching activity from place (and other dimensions of daily life) in order to contextualise these in the analytical stage of the investigation (Ellegård, 2019a).

2.4 Social issues and perceptions

Social issues, feelings, perceptions and emotions already represent a viable part of time-geographic research and frequently use the approaches of relational geography (see for example, Hall, 2019). The interactions between individuals within pockets of local order and activity spaces can be seen as departing points (cf. Liu et al., 2018; Dixon et al., 2020). Thus, ‘carescapes’ related to children, the disabled, the elderly and women can be discussed (e.g. Dyck, 1998; Davies, 2001; Wiles, 2003; Yantzi and Rosenberg, 2008; Bowlby, 2012; Craig and van Tienoven, 2019; Landby, 2019). The issues of loneliness, social and socio-spatial exclusion and segregation emerge right away (Schnell and Yoav, 2001; Schönfelder and Axhausen, 2003; Lee and Kwan, 2011; Shen, 2019; Dixon et al., 2020; Frantál and Klapka, 2020). The emotive load of stations and paths is discussed by McQuoid and Dijst (2012). The references from a variety of disciplines indicate that these issues are not unique to time-geographic research, but there is a common ground in everyday activities and activity spaces, which are distinct time-geographic concepts.

The global pandemic clearly affects social issues and the perceptions of individuals. Social contacts are limited and social distancing (which also is geographic) is recommended. This can increase the feelings of loneliness and social exclusion, particularly for the elderly, single mothers, single men and women, persons on parental leave, disabled persons, etc. (see for example: Brooke and Jackson, 2020; Gao and Sai, 2020). The results of an extensive study from France show that during the lockdown, most people have experienced a slowing down of time, which was not explained by the levels of perceived stress or anxiety (although these were considerable), but rather by the increase in boredom and sadness felt in the lockdown situation (cf. Droit-Volet et al., 2020). Manzo and Minello (2020) report how the increase in remote working during the lockdown has created unequal domestic rearrangements of parenting duties with respect to gender relations. They highlight the key role that working mothers have played in creatively and effectively organising caretaking activities to resist the burden of social distancing, child-care, and maintaining a degree of ‘normalcy’.

The “virtualisation” of social contacts is for most people probably an unsatisfactory and imperfect solution (Gao and Sai, 2020). For instance, older adults do not command the information and communications technologies (ICTs) as younger generations (in general) do and their feelings of isolation are accordingly not helped (cf. for example,

Thulin, et al., 2020). Additionally, the issue of care of other persons in need (children, the disabled, the elderly) emerges. Kindergarten and school closures make it difficult to combine care and work, which can compromise the economic situation of families and households. Moreover, it has been found that there exists a wide disparity amongst sub-populations, such as those with higher incomes who are able to access technologies that can ensure continuing education and social contacts digitally during isolation (Nicola et al., 2020).

3. Post-pandemic time-geography: Future prospects?

The pandemic event of 2020 will affect time-geographic research and its future prospects, just as most likely the case for many sciences and the arts. Before returning to the issues touched upon above, we will discuss some points that might be of interest when redefining, expanding and stressing some of the future prospects for time-geographic research.

Beforehand, it might be useful to hint very briefly at some philosophical and psychological implications of the 2020 global pandemic. This event, not experienced by many if not most ever before, affects the feelings, the emotions and the attitudes of individuals and society. It brings more fear, worries and anxieties than joy, relaxation and contentedness to existential emotions (see also Dijst, 2019). These emotions are reflected in human needs, values, goals and ‘projects’ that may be ‘violated’ by the pandemic, in comparison to the situation just a year ago. Even though further discussion of the philosophical and psychological implications is well beyond the scope of this article, individual emotions are certainly reflected in social mood as shared (i.e. aggregated) states of mind.

The satisfaction of human needs and values and the achievement of goals rest on the fulfilment of the activities necessary to reach the goals of specific ‘projects’, as formulated by individuals and manifested in their activities. These are necessarily anchored in the time-space, wherein people interact with other persons and objects in the geographical environment. This is clearly reflected in *behaviour in time space* and *time space behaviour* (also referred to just as *spatial behaviour*: Golledge and Stimpson, 1997). While projects in the time-space are directly related to efforts to fulfil one’s needs and to accomplish the goals of one’s projects, the time-space behaviour manifests the spatio-temporally overt activities of individuals. The former concept includes strategies to satisfy one’s demands and hopes and is based on spatial cognition and spatial choice, while the latter concepts include concrete steps carried out in time space to realise the strategy based on spatial interaction and spatial mobility concepts.

3.1 The use of constraints

Time-geography includes a system of *constraints*, usually classified into three main groups: authority, capability and coupling constraints (Hägerstrand, 1970), which play an important role in analysing human life. While concepts similar to authority and capability constraints appear in most social sciences, the coupling constraints are unique to time-geography. All three types of constraints are of value in the new pandemic situation.

As indicated above, the concept of *authority constraints* has gained some new qualities. It suffices to take examples from Europe, where we have witnessed numerous examples of lockdowns, quarantines and reactivation of state borders

in the Schengen Area by the overall authorities – a situation not seen since the fall of the Iron Curtain. Not only tourism travel, but also everyday activities have been affected by these constraints, including work, education, shopping and socialising. Thus, adaptation strategies to the socio-spatial restrictions are a very appealing theme for time-geography.

The definition of *capability constraints* has not changed much during the past decades. Hågerstrand (1970, p. 12) says that “‘*Capability constraints*’ are those which limit the activities of the individual because of his biological construction and/or the tools he can command”. Further, Ellegård (2019a, p. 44) states that “‘*Capability constraints*’ concern the individual’s opportunities related to her bodily and mental functions...”. Attention should be paid to ‘mental functions’ in the latter definition. The global pandemic has shown that there are psychological, and consequently behavioural, constraints of an intrinsic quality that prevent individuals from fulfilling their needs and the goals of their projects. They are related to fear and worries and they are clearly manifested in individual paths. Individuals may tend to think twice about the way to accomplish their projects (see also Section 3.3).

The concept of *coupling constraints*, which will be discussed in the following subsection, concerns the opportunities for individuals to meet and interact in the time-space when necessary for performing activities that will help them to achieve the goals of their projects. The pandemic makes it more difficult to meet physically and, in this respect, we can refer to the already-mentioned issues of isolation and loneliness (see Section 2.4). In contrast, Tyner and Rice (2020) suggest that the pandemic offers people an opportunity to think more deeply about their lives, who and what they value in society towards achieving meaning in life.

3.2 Role of virtual bundles

Many everyday activities have been transferred to a *virtual world*, even though the individuals (as human bodies) are always (time) located somewhere (place). On the one hand, such a virtual world enables one to mitigate the feelings of isolation and loneliness, but, on the other, coupling constraints have significant drawbacks concerning some projects.

On-line shopping, for example, involves many new kinds of couplings with qualitatively different consequences compared to shopping in the grocery store. The on-line shopping customer stays at home (decoupled from the shop) and sends the order to the shop. Then someone else picks and packs the goods (they couple the goods into a specific bundle), and thereby this someone decides what quality of a specific good that is chosen. Then, someone else transports the goods to the customer’s home, in order to couple them to the customer. Hence, the goods are coupled to many different persons and places on the way to the customer. The on-line shopping, then, involves more physical couplings than in-the-shop shopping.

Our personal experience from teaching and research can bear witness to some of the negative effects. Recent lecturing activity has shown that personal contacts with students (simultaneous physical couplings in the time-space) are irreplaceable. We feel that the quality of the educational process tends to be compromised in the virtual space that is, under current conditions, generally and easily available with financially affordable technologies. This situation appears to be in contrast to our research activities which do not seem to have been severely challenged by

the new situation. For researchers already in the scientific community, then, physical contacts with colleagues are not as important as in the case of the teaching process. In a longer time perspective, however, research claiming personal meetings in empirical studies might be problematic, especially when the research problem concerns sensitive issues. New generations of researchers entering the scientific community will meet new kinds of coupling restrictions. We admit that these examples are subjective, reflecting our experiences, and we do not claim that they hold true generally. Nonetheless, it seems clear that some bundles in virtual time space can be less effective than others with respect to project accomplishment, which is also relevant for in-depth research. As indicated above, this is not only the case in education, but also of work (home office, telecommuting), shopping and social activities.

3.3 The meaning of stations and paths

Until recently, two traditional and basic time-geographic concepts, *station* and *path*, have been considered as concepts that needed to be assigned some added value (e.g. in the form of emotional load, quality of life, transport mode, etc.), but now they seem to have regained their original importance *per se*. One specific physical *station*, ‘home’, is garnering multiple meanings – a shelter (original meaning), an office or a workplace, a place for education and shopping, but also a cage. Perhaps as a result, other physical stations are losing their previous meanings. Speaking of home, what might be of interest now are the interactions between household members (from the point of view of age, sex, social roles, etc.) and the use of energy and consumption behaviours of households. Another interesting issue is the changing role of virtual “stations” (and portals, message windows: see Miller, 2005b), when virtual bundles are necessary. There may be a shift from the prevailing leisure function of virtual stations to ‘must activities’ functions. Thus, peoples’ activities in virtual space may gain different qualities than before the pandemic. Hence, there is a need for a concept where “virtual stations” or “virtual bundles” are considered.

Until recently, the concept of (individual) *path* has been interpreted by many researchers only as a basic record of human existence in the time-space. In the pandemic situation, it seems that this spatio-temporal aspect comes to the fore again. This is particularly true for health issues and the already-mentioned backtracking of infected persons and the identification of respective bundles – possible sources of further infection spread. Here, we return to the roots of time-geography and Hågerstrand’s research on the diffusion of innovations, where the virus is an innovation of nature, and migration, where peoples’ movements and couplings in time and space serve as diffusion motors. It may be appealing to examine the reasons for a group of individuals, what were their choices of their particular paths, for their preferences or rejections of some directed path. Safety rather than any traditional geographical distance, speed or cost may prevail, when individuals seek their path through their prisms to move from one station to another. Additionally, the perspective of couplings between the human world and the environment is an increasingly important issue. As the areas occupied by human activities increase, wildlife meets hard restrictions (for example roads, buildings, fences) and thereby the prisms for animals and humans increasingly intersect, causing more coupling possibilities. This will increase the risk for new diseases to spread from animals to humans.

In a longer temporal perspective, some intriguing questions for future time-geographic research are: What new routines will prevail after the pandemic has loosened its grip on humanity? How will people perform their activities to achieve the goals of their projects, and what stations will become more or less attractive than before? What lessons are learned in terms of the importance of couplings and how they restrict daily life?

3.4 Time-geography in the post-Covid era

As the global pandemic has had a huge impact on human lives and its consequences are likely to be reflected in human behaviour for some time after it fades out, insights into time-space aspects of human behaviour in the Covid era brings new challenges also to time-geographic research, and the need to scrutinise again some of its theory and concepts arises as well. In this article, we have turned our attention to four aspects of time-geographic research, which can be related to the Covid pandemic and its future consequences. The role of time-geographic techniques to understand time-space processes and to track individual's existence in the time-space emerges once again. Routines, rhythms and random activities in the time-space reflect the framework 'set' by the pandemic and its impacts on everyday life, households, work, education, health, environmental and consumption issues. As a result, the importance of virtual bundles increases and many 'must activities' partly move onto the Web. Finding themselves in new situations, individuals may experience social and perceptual unease and stress, which can be felt differently in specific population groups (children, women, men, the disabled, etc.). Therefore, several time-geographic concepts seem to gain new qualities, significance and meaning, in particular the concepts of *constraints*, *virtual space*, *bundles*, *paths* and *stations*.

4. Special Issue of the Moravian Geographical Reports on "Current issues, methods and applications in time-geography"

The articles collected in this Special Issue address several key problems in time-geographic research. The original articles are based on pre-pandemic research: the date of the initial expression of authors' interest to participate and the submission of abstracts was November 30, 2019, and the deadline for submission of full articles was March 1, 2020¹. Nonetheless, there is a thematic affinity in these articles each one presenting new aspects and uses of the time-geographic approach, that respond in various degrees, to the questions and challenges raised above in this introductory article.

The first three articles take up some important issues for time-geographic research related to methodological questions. Two articles are concerned with ICT in general and potentially, tracking technologies. Mobile phone data are considered one of the most promising information sources for mapping the spatio-temporal activities of people. Large-scale mobile phone datasets are widely applied to monitor the daily life of urban populations and to examine the structuring of urban environments. Martin Šveda, Michala Sládeková Madajová, Peter Barlík, František Křižan and Pavel Šuška, in their article, develop and discuss a methodological procedure that uses such data to observe

temporal differences of the human presence in the city of Bratislava. The authors illustrate how the records of the mobile network infrastructure can be used as a suitable proxy variable for complex human activity at the city level, in the sense that they capture not only specific activities (such as the work cycle of a given locale, or shopping more generally) but various kinds of spatial practices. Stanislav Kraft, Tomáš Květoň, Vojtěch Blažek, Lukáš Pojsl and Jiří Rypl have mapped the daily mobility patterns of university students in an urban environment using time-space diaries, GPS loggers and smartphone applications. They analyse the spatial patterns of intra-urban mobility using basic mobility indicators (trips, distance, time), travel behaviour (use of transport modes) and specific time-space bundles (spaces of concentration of particular time-space trajectories). In doing so, they compare the three mentioned research methods and technologies according to their tracking accuracy and informative value, for the case study of České Budějovice in southern Bohemia, the Czech Republic.

In the next article, Robert Osman, Vladimír Ira and Jakub Trojan discuss the limitations of existing methodological approaches to the comparison of time policies between cities, and the international comparisons of urban times in general. The authors introduce the approach of a comparative chrono-urbanism, providing the theoretical framing, systematic procedures and an empirical illustration of the comparison of urban times using the analysis of timetables of the cities of Brno (the Czech Republic) and Bratislava (Slovakia).

Next, we turn our attention to the rhythms of health-related activities, clearly principal issues in the pandemic era. At present, people with severe mental illness face different interventional landscapes compared to some decades ago, when mental hospitals dominated the Western world. Gunnell Andersson, Katerina Vrotsou, Anne Denhov, Alain Topor, Per Bülow and Kajsa Ellegård investigated people diagnosed with psychosis for the first time, over a 10-year period, and explored what interventions (defined as specific "spheres" in the article) men and women experienced. Based on data from registers and using a time-geographic representation, the authors visualised individuals in terms of their 10-year trajectories, where their transitions between the different spheres were highlighted. In the following article, which used a more qualitative approach, Eva Magnus, Klara Jakobsen and Randi Johansen Reidunsdatter demonstrate how time-geographic diaries, supplemented by in-depth interviews, can be effectively used to map and understand the daily activities and specific everyday life projects that improve the quality of life of breast cancer survivors. The findings of studies such as these, definitively can be implemented in the development of more individual and peer-driven health care services.

The following two articles are concerned with perceptions and social issues. The concept of topophobia has been known in Geography for decades (for example, Porteous, 1987). The perception of fear within an urban environment is often represented by fear of crime and it usually is exhibited in certain spatio-temporal concentrations. Petr Šimáček, Miloslav Šerý, David Fiedor and Lucia Brisudová deal in their article with the analysis of topophobic places in an urban environment. They focus on the temporal dimension of the fear of crime and show how the intensity of and the reasons for fears vary depending on time of day and place. In their

¹ Actually the day when the first three cases of the Covid-19 disease in the Czech Republic (the country where the MGR journal is published and where two of the authors of this paper live) were officially confirmed.

article, Bohumil Frantál, Pavel Klapka and Eva Nováková study space-time constraints, isolation and the loneliness of older adults in urban environments. Their model of social-spatial isolation, based on data from space-time diaries and questionnaires, shows that isolation is significantly associated with the frequency of performing specific at-home and out-of-home activities, which are constrained by age-related health condition, financial opportunities, spatial mobility and time consumption. This study supports the hypothesis that socio-spatial isolation is a multi-component, place-dependent and gendered issue.

In the last article, Chunjiang Li, Yanwei Chai and Yoshio Arai provide a summary of the diffusion and development of time-geography in East Asia, specifically in Japan and China. The authors tell the story about how and why time-geography diffused into East Asia by presenting and analysing the academic life paths of the two key scholars in the field. The effectiveness and disadvantages of the academic life path method as a tool in mapping the diffusion of a scientific discipline, is also discussed.

As a continuing thread throughout these articles, there is an inherent presence of uncertainty entering into everyday lives from the pandemic. As indicated recently by world renowned physicist Carlo Rovelli in *The Guardian* (Monday, 26 October, 2020): “Between certainty and complete uncertainty there is a precious intermediate space – and it is in this intermediate space that our lives and our decisions unfold”. Perhaps, in the real world of everyday lives and choices, this very thin boundary zone can best be explored by time-geography.

This volume of articles represents the contemporary thematic diversity of research into time and space, including other disciplines than geography. It mirrors the ambitions of Hägerstrand to create a “language” that enables communication between disciplines. Additionally, both quantitative and qualitative approaches to time-geographic issues are documented. The articles show how the theory and methods of time-geography serve as an inspiration and relate to the application potential of Geography as a discipline. Thus, the reader is presented with various aspects of human behaviour in the time-space, its record, manifestation, consequences and implications, in brief, knowledge which can be used to resolve various aspects of current social problems.

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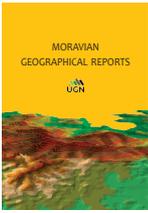
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Mobile phone data in studying urban rhythms: Towards an analytical framework

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Abstract

Mobile phone data are considered one of the most promising information sources for monitoring and measuring the spatio-temporal activities of the population. Today, large-volume mobile phone datasets are widely applied to monitor the daily life of the urban population and to examine the structuring of the urban environment. In this paper, we discuss and develop a methodological procedure that uses such data to observe temporal differences of human presence in Bratislava, Slovakia. The study is based on a large-scale dataset of hourly records of signalling exchanges (VLR data) from all major mobile network operators in Slovakia. The records of the mobile network infrastructure are used as a suitable proxy variable for complex human activity at the city level, in the sense that they capture various kinds of spatial practices, and not only some specific activities (work cycle of a given locale, shopping, and similar events). Such an approach allows the classification of urban space using diurnal logs activity curves of mobile network cells. Six temporality types in Bratislava were identified, which may be designated as examples of an urban chronopolis. The results show the potential of the proposed method for measuring place temporality in cities and monitoring the urban environment with geo-referenced mobile phone data.

Keywords: mobile phone data, diurnal rhythms, urban timespace, chronopolis, Bratislava, Slovakia

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1. Introduction

The availability of spatial and temporal data through various location-aware technologies has led to increasing interest in time geography in the past decade (Sui, 2012). Mobile phone data are one of the most promising data sources to monitor daily life and short-term processes because of their ability to capture population movement patterns and trajectories (Deville et al., 2014; Kang et al., 2012).

These large volume datasets are considered a valuable indicator of human presence and provide us with the opportunity to track spatial mobility patterns at an individual level (Ahas et al., 2010; González et al., 2008; Novák and Temelová, 2012; Song et al., 2010), as well as to map the movement and activity of the population by using aggregated data (Ma et al., 2019; Ratti et al., 2006; Reades et al., 2009; Yuan and Raubal, 2016). The mobile positioning has found considerable use in mobility and traffic studies (Järvi et al., 2012; Calabrese et al., 2011), but also in areas such as

crisis management (Bengtsson et al., 2011), the monitoring of foreign tourist visits (Ahas et al., 2008; Šveda et al., 2019), or the spread of epidemics (Weselowski et al., 2012). Urban space and dynamic processes in cities are particularly of central interest, where the usefulness of mobile phone-based data has been demonstrated (Calabrese et al., 2011; Csáji et al., 2013; Nemeškal et al., 2020; Ratti et al., 2006; Sagl et al., 2014; Slim and Ahas, 2014).

Calls to study the diurnal variations of the population in urban localities from the viewpoint of the time geography paradigm were made decades ago (Bromley et al., 2003; Goodchild and Janelle, 1984; Muller, 1982; Taylor and Parks, 1975), but technological advances in mobile communications have brought new challenges in revealing time-space changes in population distribution. The ability to monitor daily movements for any time-period has opened new horizons in studying everyday urbanism and urban rhythmicity. Several attempts to include temporal aspects

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of urban life using mobile phone data have explored spatio-temporal movements of population and associated urban or suburban rhythms (Ahas et al., 2015; Ma et al., 2019; Nemeškal et al., 2020; Xia et al., 2018). Previous research has shown that mobile positioning allows us to study rhythmicity more precisely than using traditional methods such as questionnaires or travel diaries. A promising feature is the possibility of conducting population-wide research with robust samples that may open new perspectives in studying the spatio-temporal behaviours of urban inhabitants and reveal patterns of urban life.

This analysis is based on unique sources of data. Instead of the more commonly-used call detail records log files (CDR data), which are generated by the mobile network only at the time of performing a telecommunication activity (e.g. call, message or data streaming), our analysis works with the dataset of aggregated signalling exchange records between mobile phone and Base Transceiver Stations (BTS) from all major mobile network operators in the area. The visitor location register (VLR) data enables us to monitor the time-space record of mobile phone users, no matter how an individual uses her/his phone. This is particularly important with respect to the changes in mobile phone usage among different population subgroups (within a national population, as well as between different countries). The primary objective of this paper is to develop and discuss a methodological procedure that uses longitudinal signalling exchange data of mobile network operators, to observe temporal differences of human presence in urban space.

The advantage of the VLR data source is in its ability to include almost complete diurnal variations of population in urban space, as it captures differentiated mobilities and time-space strategies. By using VLR data we can monitor not only the work- and home-related movements, but also capture 'invisible' routine activities and movements which fill the timespace. This goes beyond the usual geographic explanations based on work-home trajectories. Analysing the VLR data we are getting closer to investigate the temporality related to a concrete place. This brings us to the concept of the chronotope as the unique combination of a specific place and specific time (Folch-Serra, 1990; Crang, 2001). Following the work of Czech geographers (Muliček et al., 2015, 2016; Osman and Muliček, 2017), place may be understood as a specific timing space composed of multiple rhythms. According to the nature of its temporality, it is possible to identify areas with analogous rhythmicity. On this basis, urban space may be classified into specific types of temporality. This study's second objective is to identify such different types of daily rhythms in the Bratislava city area. Specifically, we want to discuss the following research questions:

- How can we utilise VLR data for the identification of local-level diurnal rhythms?
- Does the collective behaviour of mobile phone users and their daily routines in the city form a specific place temporality?
- What does a specific composition of local rhythms say about the urban environment and the character of the everydayness of its inhabitants?

2. Theoretical background

2.1 Urban rhythmicity

Ever since Torsten Hägerstrand (1970) proposed a Time Geography, the daily rhythms of city everydayness have

been studied by researchers in order to better understand the quality of urban life. The relationships of time and space in the urban environment offer a wide range of topics and interpretations (Ahas et al., 2010; Calabrese et al., 2010; Edensor, 2012; Goodchild and Janelle, 1984; Muliček et al., 2015; Muliček and Osman, 2018; Muller, 1982; Ratti et al., 2006), but we will concentrate on the understanding of a city as rhythmic compositions. This means interpreting the places not as static, but more like an action or event (Crang, 2001; Paiva, 2016).

In studying urban rhythmicity there are two theoretical traditions: Lefebvre's rhythmanalysis and Bakhtin's concept of chronotope (Osman and Muliček, 2017).

Among the works framed by time-space duality and its dimensions, the contribution of French philosopher and sociologist Henri Lefebvre is probably the most influential. According to Lefebvre, everywhere where there is an interaction between a place, a time and an expenditure of energy, there is a rhythm (Lefebvre, 2004, p. 15). It is actual location and the materialisation of time through rhythm that makes rhythm analysis interesting for analytical use. Rhythm is not the object of analysis, it is itself an analytical tool that allows the research subject to be approached holistically as an 'open totality' (Lefebvre et al., 1996, p. 230).

Lefebvre's (2004) approach to rhythmanalysis could be used as a new operational approach for multiple versions of time geography (Sui, 2012, p. 12), as an indicator to measure functional diversity, and as a tool to evaluate the quality of urban space (Ahas et al., 2010). Since the city is made up of people and their activities (Wirth, 1938), research into urban rhythms has been closely related to the concept of everyday life. One can recognise rhythms, perceived in the form of regular temporal patterns of activities or practices, everywhere in everyday urban life. Rhythms involve interaction between people and spaces, which respond to the morphology of the spaces. Thus, urban rhythms are always polyrhythmic in the sense of rhythms with various speeds, trajectories and practice (Lefebvre, 2004). In this sense, urban polyrhythms are a composition of different human activities in specific localities over a specific time. It is obvious that the timing of daily human activity may vary among different parts of the city, and the nature of space-time trajectories may be (and it is) dissimilar. The framework enabling the study of the dynamic aspects of spatiotemporal organisation and to capture the polyrhythmic nature of an urban place, is the concept of chronotope.

The concept of chronotope was initially introduced in the 1930s by Mikhail Bakhtin, the Russian philosopher, to describe the way literature represents time and space. In his inspiring work, he says that it is impossible to understand place without time and time without place (Bakhtin, 2002, pp. 15–16). According to Bakhtin, whatever is looked at is surrounded by the backdrop provided by the chronotope's time-space coordinates, where temporal and spatial determinations are inseparable from one another (Bakhtin, 1981). While Bakhtin utilises this approach in the analysis of literary narratives, Folch-Serra (1990) makes it relevant to geographical discourses by extrapolating the chronotope as a connection between space and time, characterised by the reversibility of moments in a temporal sequence, and by their interchangeability in space. The advantage of the chronotope lies in the fact that neither space nor time is privileged: chronotopes are places of intersection of temporal and spatial sequences (Folch-Serra, 1990, p. 261).

The concept that directly integrates Bakhtin's chronotope and Lefebvre's rhythmanalysis was introduced by Crang (2001), who understands the chronotope as a unity of a specific temporality associated with a specific place. The temporality of place is conceived as a unique combination of various rhythms, and a place is perceived not necessarily at a singular time but a spatially- bounded constellation of temporalities. By employing the chronotope, the locality can be grasped not only in a spatial/graphical way as a delimited piece of space, but also in a spatio-temporal way (graphically and narratively) as a timed, rhythmised place (Osman and Muliček, 2017, p. 48). Thus, chronotopes refer to the ways in which space and time are always bound together, as well as to the particular forms in which such conjoined space-time is engendered, experienced and ordered in historically and geographically differentiated social life (Howell and Beckingham, 2015, p. 935). Similarly, Remm and Kasemets (2019) perceive the chronotope not only as a concept of a spatio-temporal organisation but also as an approach to experience and to interpret landscapes. Grasping the analytical construct of chronotope into more topologically-oriented view, R. Osman and O. Muliček (2017) offer a space-time conceptualisation of a place for which they use the term of chronopolis, originally developed by M. Laguerre (Laguerre, 2003). Osman and Muliček (2017) have linked this concept to the city-scale level by combining the polyrhythmias of individual places (chronotopes) into equally rhythmic but spatially dislocated polyrhythmias. They argue that the character of a place is determined not only by what is in that place, but by synchronisation with other places through rhythms of over-local scope. Their intention is to catch rhythmic analogies within a set of spatially dislocated urban chronotopes. The chronotopes attached to different localities but showing analogical rhythmic profiles represent a chronopolis (Osman and Muliček, 2017, p. 49). In such a framework, the city is organised in specific types of temporality.

The chronopolis in this article is used to describe a common polyrhythmia of individual urban localities represented as urban grids – the basic spatial unit under investigation. This polyrhythmia is expressed by the diurnal course of city users recorded at the cell-level of a mobile network infrastructure. In this case, the attention is on the presence (or absence) of permanent city users as the most important element constituting the timespace character of a place – rhythmised place. The power of mobile phone data does not lie only in detecting the absence/presence of urban dwellers, but it allows us to study more deeply the rhythmic composition of an urban landscape.

2.2 Detecting urban rhythms with mobile phone data

The framework allowing researchers to capture the polyrhythmic nature of urban space can be approached from different angles and using various data sources. One of the most common sources are the call detail records log files (CDR data), that arise from any activity of a mobile phone with a mobile network connection and are routinely collected by cellular network providers. Diurnal call activity curves based on CDR data are extensively used in research (Ahas et al., 2015; Isaacman et al., 2011; Järv et al., 2012; Kang et al., 2012; Ratti et al., 2006; Sagl et al., 2014), but they do have some limitations. Mobile phones are used irregularly during the day and among different subgroups of the population, based on socio-economic characteristics as well as attitudes, lifestyles or habits (Castells et al., 2006). This makes CDR data sparse in time because they are generated only when a phone engages in a voice call, text message or data transmission.

Another approach is based on a (random) sample of mobile phone users, supported by a detailed questionnaire of participants' diurnal activities (Ahas et al., 2010; Novák and Temelová, 2012). Building upon this practice, we can capture the space-time movements and daily rhythms of individuals and examine the connections of urban users with different time-functions in different locations. Problems related to this method are linked to the representative nature of the sample, the coupling of participants' reports and trajectories, and privacy issues. Collecting such data for a large number of individuals is not a simple task. Moreover, the time-space trajectories are not easily adaptable for nation-wide mapping. The key problem lies in the extrapolation of network-based samples for the whole population, and the correct interpretation of the resulting time-space differentiation. Such a rather unclear method of extrapolation is also a common feature in many single mobile network operator-based approaches.

One relatively common feature of various mobile-network-based approaches is the 'blurry' aspect of mobile phone data utilisation. The characteristics of mobile phone log origins and their processing, the technique of positioning (the BTS position/centroid of radiation polygon), the queries to extract meaningful locations (e.g. home and work localisation) or the spatial aggregation of cell-based data into territorial and administrative units, are hidden behind the data processing of the data provider. The 'black box' character of some mobile phone-based analyses raises questions about research reliability and validity. Clearly, the confusion is a consequence of privacy issues and the precautions of mobile network operators (MNOs). As researchers cannot directly access MNOs' strictly protected databases, there is an 'intermediator' which prepares queries for end users such as companies, governments or scientists. On the one hand, ensuring secure access to data through a data processing company provides a unique opportunity to exploit the potential of mobile phone localisation data, while maximising the anonymity of their users. On the other hand, the researchers lose control on the whole process of data processing. Even so, by jointly analysing the whole signalling exchange of all major MNOs, we want to overcome above-mentioned limitations and bridge the trust gaps.

There are several advantages that support the use of mobile localisation in analysing urban rhythms. The robustness of mobile phone datasets can play an important role in the description of the polyrhythmia of individual urban places (chronotopes), as these new data streams provide an unparalleled picture of human activity and spatial shifts, which until recently have been very difficult to quantify on timescales relevant to the local level. Another advantage is the multi-scalar nature of mobile network data, as the granularity of mobile cells enables the city to be perceived as a set of chronotopes bound into a network. The ubiquity and standardised nature of mobile infrastructure create a long-term framework to monitor the spatial variability of the population at a high spatial and temporal resolution (Ratti et al., 2006; Reades et al., 2009). Raw mobile phone data, however, are not enough for any attempt to target a more holistic interpretation of urban chronotopes/chronopoles. Producing high-level knowledge from the low-level features (time-space location) of raw data requires additional contextual information (Grinberger and Shoval, 2015). Yet, with increasing connectivity, the mobile phone datasets facilitate a more comprehensive data source by applying geo-tagged social-networks-related content (Crooks et al., 2015; Tu et al., 2017). Coupling semantic information with mobile

phone data is not a straightforward task, although it does offer an approach to reveal the evolving nature of urban living as rhythmic composition. Until that happens, we can think through the topology and texture of urban temporality using fine-grained data of individual daily human activity from the MNOs' visitor location registers.

3. Data and methods

In this paper, we present a procedure for analysing the dynamics of daily routines of city users by using longitudinal signalling exchange data (VLR data) from a mobile network. These data are automatically generated records produced by the mobile network at regular checks (pings) on connected devices. Individual BTS stations send a signal to all available and connected devices at regular intervals (defined by area/operator). Based on its location and network utilisation, a specific BTS station is determined which will provide the signal to a particular device, thus ensuring the best coverage for each device within range. Preference of connection is given to an antenna with a more advanced transmission technology over one with a stronger signal (which may not be the closest in distance). At a given time, the VLR records the cell-level locations of all mobile devices, both active and idle. The observation of VLR records provides an instantaneous description of the location of all mobile devices at cell level. Every mobile device generates a log at each change of the BTS station, generating tens to hundreds of logs per day. In addition to the more commonly used CDR data, the VLR data enables us to monitor the time-space record of the mobile phone user no matter how an individual uses her/his phone. This is particularly important considering the changes in mobile phone usage. While in the past we have used mobile phones mainly for voice calls and SMS messages, currently this use is diminished in favor of data services (social networks, instant chat, etc.) and passive use of the phone (e.g. various applications which do not require an active interaction).

The data used in this study were collected within the telecommunication network of the three major mobile network operators in Slovakia, capturing more than 330 million logs of 928,086 mobile network users (unique phone IDs), which have been monitored in Bratislava (Slovakia, approximately 430,000 inhabitants). Mobile network localisation data were recorded in the 14-days period from 26.11.2018 to 9.12.2018 (a typical period which did not correspond with any national or school holidays). The whole dataset, however, was not suitable for direct analysis. The fundamental challenge was to reject phone records of irregular city users (visitors) or of random temporality. The present framework is based on the concept of the so-called anchor-points (Ahas et al., 2010), which are represented as the main nodes of human activities that form the skeleton of daily movements. Using a suitable algorithm, we can extract the information about the basic anchor points of 'home' and 'work' from the mobile operator's network. In practice, it is mainly about identifying places (cell coverage areas) of most frequent day- and night-time localisation. Data on the concentration of day and night localisation allow us not only to specify the spatial distribution of the population but also to extract data about the expected daily transportation flows.

The procedure for the estimation of the temporal structure for a given population grid consists of the following steps (see also Fig. 1):

1. First, the cell footprint is derived from antenna configuration parameters (height, tilt, beam-width) in combination with cell tower location. This spatial information associated with the cell is reduced to a cell centroid. Due to the high level of sensitivity of such data, this procedure is managed by mobile network operators. No cell footprint, nor the location of the cell tower or cell size data are available;
2. In the second step, the number of mobile phone users (unique phone IDs) is extracted at each BTS tower, whose radiation polygon serves a part of the monitored

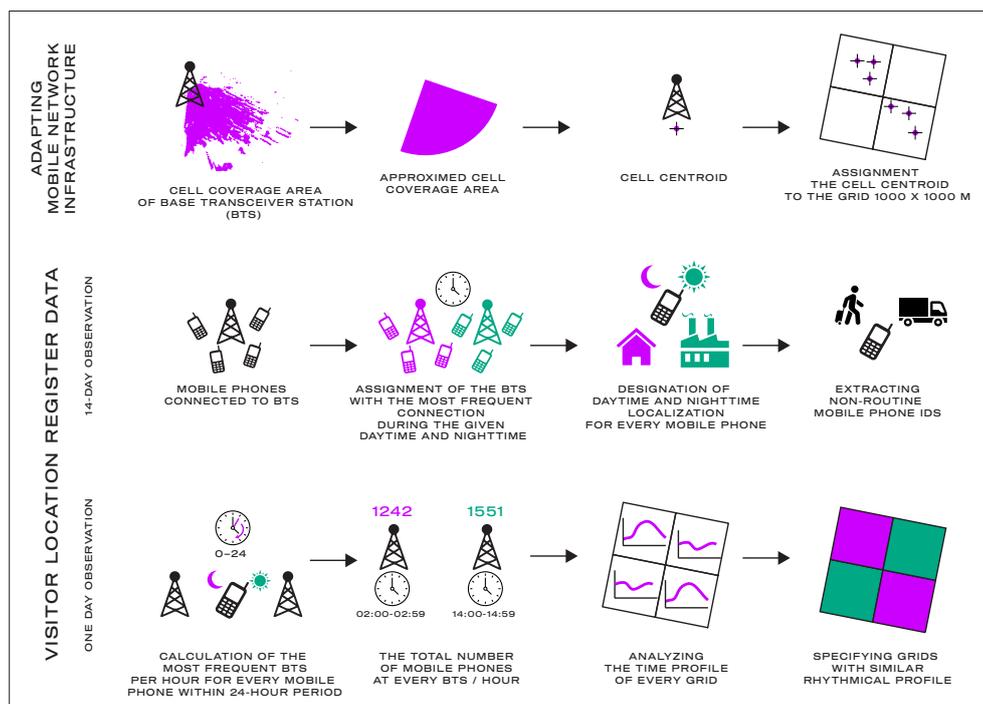


Fig. 1: Procedures for the temporal structure analysis using network-based localisation in the mobile network (visitor location register data)

Source: authors' conceptualisation

territory. Besides traditional CDR data sets we used the VLR data, which represents the whole signalling exchange between the network and the mobile device and can be used to infer the location of every mobile phone with the highest possible spatial and temporal accuracy allowed by network-based data (see Ricciato et al., 2017). We monitor the number of phone records during the day (daily location from 09:00 to 15:00) and during the night from 23:00 to 05:59. A 2-week time series of VLR data was used in this study in order to reduce non-routine localisations, aiming for spatial patterns in the average daily rhythm of human activity. We worked with a 10-day period for nighttime localisation (2-weeks period without weekends) and 6-day period for daytime localisation (Tuesday–Thursday) in order to reduce the impact of weekend activities on Friday and Monday. The resulting cell coverage area for work (daytime) and home (nighttime) localisation is estimated as the cell with the highest ratio of phone records. The resulting database consisted of approximately 8,000 ‘work’ and ‘sleep’ locations (cell coverage centroids) of 822,165 unique phone IDs. The spatial distribution of daytime and nighttime localisation is shown in Figure 2;

3. Only the phone IDs with assigned daytime (754,257) or nighttime (536,976) localisation in Bratislava were

subsequently used for temporal analysis in the spatial frame of population grids. We chose one particular day (Wednesday, 5.12.2018) and at every hour we identified the most frequent mobile cell for a particular phone ID. Subsequently we counted the number of unique phone IDs on the grid level. The advantage of the grid over irregular areal units is stability over time, whereas units devised for purposes such as census enumeration tend to be periodically revised and also to relate strongly to population distributions at specific times, such as the implicit connection between census geographies and nighttime residential population distributions (Martin et al., 2015, p. 757). To reduce the amount of noise due to locating errors, grids with the total number of users during the 24-hour period under 3,000 were excluded from analysis (according to empirical observation in remote areas). In most cases these grids were localised in non-urbanised areas outside the city limits; and

4. The final step was to analyse the rhythmic profile of every grid to integrate places of similar rhythmicity. The following features for defining the particular temporality type were considered: the peak time of mobile phone users’ presence, the time of any secondary peak, the duration of peak presence and the time when the grid is abandoned.

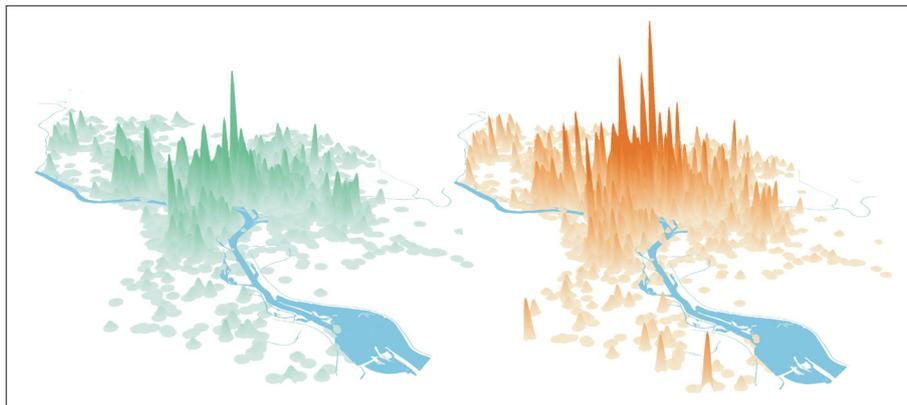


Fig. 2: Nighttime (left) and daytime (right) localisation of mobile phone users in Bratislava. Kernel density of the number of unique phone IDs with a long-term day and night localisation

Sources: (data) Market Locator SK: longitudinal signalling exchange data of Slovak Telekom, Orange Slovensko, O2 Slovakia (N = 822,165); authors’ analysis

In spite of the apparent simplicity of the procedure, it is important to be aware of a number of limitations arising from the principles of mobile network operation and the legal conditions of mobile user data processing when interpreting mobile localisation data. We will try to highlight the most important ones:

- i. The number of unique phone IDs cannot be reliably aligned with the number of people (individual users). The reason is that we cannot assume that every citizen has a mobile device, as well as we cannot exclude people using multiple SIM cards from the database;
- ii. The mobile phone user may not be the same person as the phone holder. For example, within one family, children can use mobile phones registered to their parents. The underestimation of the child component in the mobile network user structure is a natural consequence of the mobile cellular subscription of the parents of children. Under-representation of seniors is a natural consequence of the aged-based digital divide (Neves and Amaro, 2012);
- iii. VLR data only roughly indicate the area that the cell or sector is serving. The spatial accuracy is contingent on the architecture of the mobile infrastructure (granularity of cell coverage areas), which depends on the type of antennas and the landscape surface (the smaller the cells, the better the location estimates). Within each technology (2G, 3G and 4G) the cell density determines the local network capacity, i.e. the maximum amount of data traffic that a network can deliver. Hence, the spatial granularity of cellular coverage depends on the density of mobile network/phone users, and on their traffic intensity. In the urban environment, it is in the range of hundreds of metres, in suburban and rural areas it can be in the range of kilometres;
- iv. The lack of cell footprint information represents a serious disadvantage of the method used here. It can be expected that augmenting the method with accurate cell footprint information will improve the fidelity of the final result (cf. Ricciato et al., 2015);

- v. One specific feature of the Bratislava urban area is its position at the border with Austria and Hungary. Seamless handover between countries allows mobile phone users to enjoy continued voice and data connectivity across the border. This, however, brings an increased number of records for the mobile cells localised near the state border; and
- vi. It should be pointed out that seasonal variations probably exist in the daily timing of human activity due to changes in driving factors, such as the length of daytime.

An important remark should be made about privacy issues in the method used here. Researchers cannot access mobile operators' raw data, so there is a "middle string" which prepares queries for end users such as companies, government users, or scientists. In Slovakia, the company Market Locator has a special contract with all three major mobile operators to mediate data distribution and to guarantee data security. This service ensures maximum anonymity of mobile phone users by presenting only aggregated data. All mobile phone users remained anonymous, so persons or their precise locations cannot be identified. The data structure is illustrated in Table 1. The attribute "subscriber_id" represents a unique identifier of the SIM card holder anonymised by a hash function, and the "cell_id" represents the BTS tower, where the position of a SIM card was recorded.

Ensuring secure access to data through a data processing company provides a unique opportunity to exploit the potential of mobile phone localisation data while maximising the anonymity of its users. By jointly analysing data from all major mobile network operators within the country, we significantly reduce the risk of under- or over-representing certain subsets of population or locations in cell-level data. It is important to remark that micro-data does not leave the mobile network operator domain.

subscriber_id	date	hour	cell_id
a5gfh78b5trf	2018-12-05	11	13590
nj6j7kl9mn23	2018-12-05	13	34568
b5nh6sf7v35	2018-12-05	5	8742

Tab. 1. The structure of data used in this study
Source: Market Locator SK

4. Results: Bratislava's urban rhythms

Bratislava has been the capital of the newly formed Slovak Republic since 1993. Today, although incomparable with its counterparts in neighbouring countries due to its modest size of about a half a million inhabitants, it has the capital city status and position that shape the spatialities of urban life and its rhythms. The modern development of the city was closely linked to industrial urbanisation, which was later underpinned by its growing importance as an administrative, political and cultural centre, being either the second city in Czechoslovakia or the capital of the independent Slovak Republic. Post-socialist transition brought once again important political and economic stimuli reshaping the spatio-temporalities of the city. Deindustrialisation, a booming service oriented economy (Ondoš and Korec, 2008) and growing administrative importance, have changed the rhythmicity of the former industrial town, influencing and influenced by daily commuting from a vividly developing hinterland due to massive suburbanisation (Šveda et al., 2016). Whereas the industrial city was characterised by a shared rhythm determined by dominant pacemakers (industrial plants) producing a rather uniform factory pattern, the deindustrialised city is associated with a significant weakening of such pacemakers cutting across the society, and thus with a distinctive individualisation of urban rhythmicity (Muliček et al., 2016).

In order to identify the most significant urban rhythm types (chronopoles) present in the city, we start the analysis by examining the diurnal time use curve at the city level (see Fig. 3). The night minimum of phone users is not surprising, as it shows Bratislava as a natural centre of employment with intensive commuting. The number of unique phone IDs with a long-term daytime localisation exceeds the nighttime localisation by over 200,000 mobile phone users. The morning starts with a rapid rise between 6:00 and 7:00 am, which can be aligned with the commuting from the metropolitan region. In a previous analysis, more than 139,000 commuting mobile phone IDs were recorded in the metropolitan area of Bratislava (BID, 2019). During the daytime, the maximum number of urban users was recorded at 3:00 pm. The later daytime peak corresponds to postindustrial societies with services-oriented employment (cf., Ahas et al., 2015). Although Bratislava is still in part an industrial city with dominant

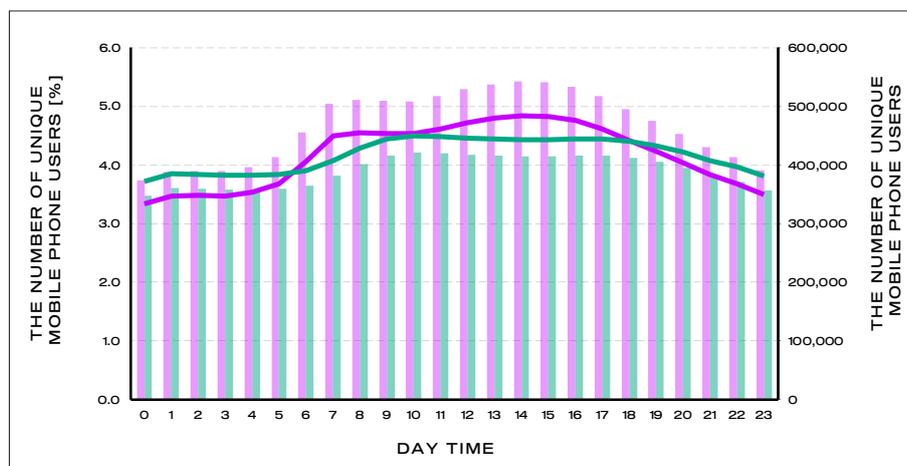


Fig. 3. Diurnal activity curve of selected days in Bratislava, Slovakia (purple: Wednesday 5.12.2018, green: Saturday 1.12.2018). Aggregated data for all network cells in Bratislava
Sources: (data) Market Locator SK; longitudinal signalling exchange data of Slovak Telekom, Orange Slovensko, O2 Slovakia (N = 822,165); authors' compilation

car production, the central parts of the city represent an important commercial and administrative centre void of industry. This fact is probably behind the slower decline of logs' activity curve in the afternoon.

The recorded number of 'sleeping' mobile phone users (536,976) suggests that there is a larger number of inhabitants living in Bratislava than the official statistics reports. Officially, according to permanent residency statistics (2018), 432,864 people reside in Bratislava, but this number has been long believed to be very unreliable. Still, we should take these estimates as a meaningful approximation of the population count rather than its precise quantification. Fundamentally, the number of unique phone IDs cannot be reliably aligned with the population density. There are several arguments which speak to the under- or over-counted numbers of the phone-based residential population. There are reasons for over-counted numbers arising from mobile communication, specifically in the case of company-owned cell phones. Especially in the business districts of Bratislava, we can expect a significant number of phones with business registration. As the distribution in Figure 2 shows, the central business district of Bratislava hosts the largest proportion of phone users with nighttime and daytime localisation. It is not easy, however, to differentiate between private and business-related communication of company-owned cell phones. Clearly, there is a significant share of company-owned cell phones and filtering those phones IDs would not be an ideal solution, as we could lose a significant number of localisation records (users). Other

arguments relate to the under-representation of certain subsets of the population (children or seniors) or locations (small and remote settlements) in cell-level data.

Analysing the rhythmic profile of each grid (chronotope), the urban space of Bratislava can be regionalised into six categories – chronopoles. The basic characteristics of the particular types of chronopoles, identified according to their common rhythmic profiles, are provided in Figure 4. The fundamental difference between particular chronopoles is based on the peak and off-peak periods. The rhythms, stemming from the presence and absence of mobile phone users, are undoubtedly conditioned by the employment patterns of city users. Therefore, it is essential to include knowledge of the prevailing functions of every urban district. In order to understand the temporality of the individual urban grid, we have investigated the character of the urban environment and the potential underlying forces (pacemakers) behind spatio-temporal patterns and differences.

The resulting spatial distribution (see Fig. 5) presents the division of urban space into relatively consistent territory types (chronopoles). Central areas show the highest concentration of mobile phone users with the peak time at noon or afternoon, while areas on the outskirts feature lower number of mobile phone users, which culminate during the night.

Following the work of Mulíček et al. (2015), on the city level the daily work cycle combines the logic of two groups of pacemakers: 'clock-time pacemakers' and 'event-time

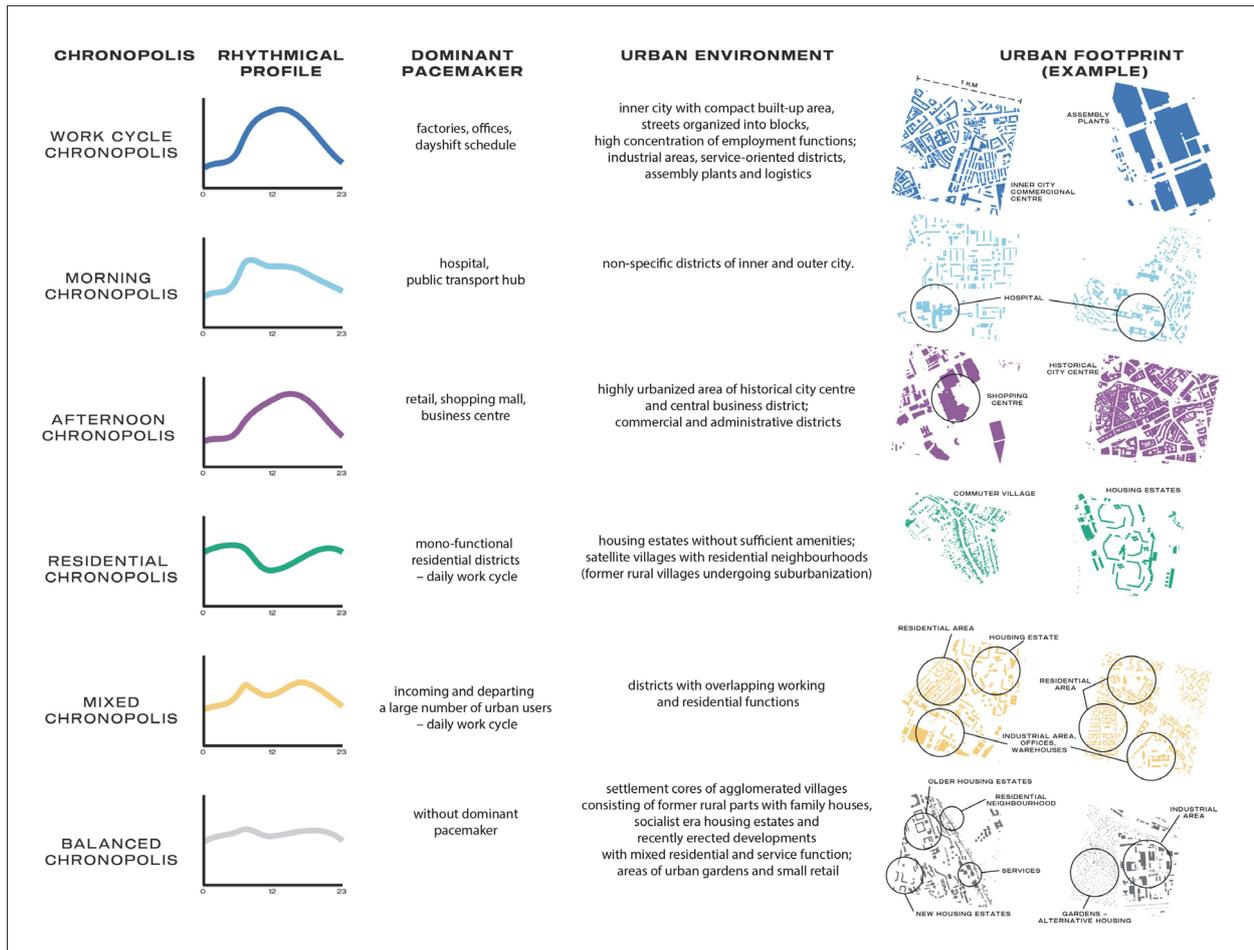


Fig. 4: The characteristics of grids with analogical rhythmic profiles – chronopoles (gridded hourly records of mobile phone users)

Source: authors' conceptualisation

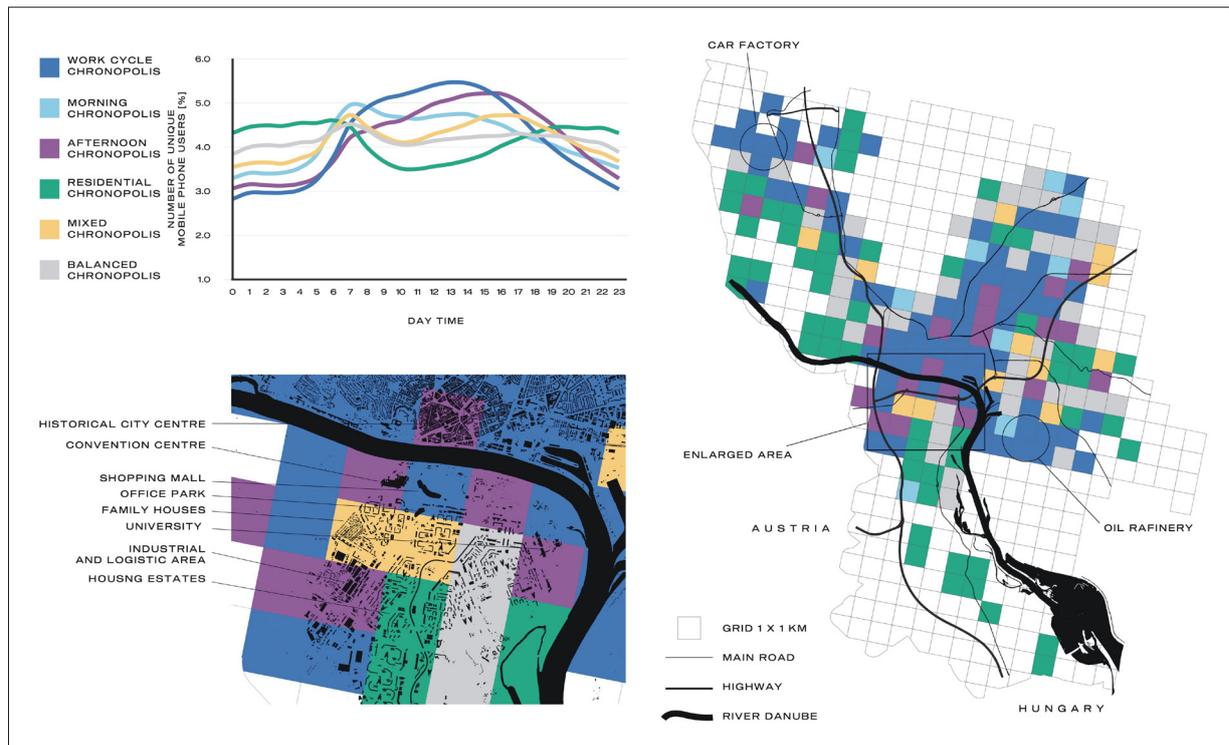


Fig. 5: The spatial distribution of grids with analogical rhythmic profiles – chronopoles. Gridded hourly records of mobile phone users

Sources: (data) Market Locator SK: longitudinal signalling exchange data of Slovak Telekom, Orange Slovensko, O2 Slovakia (N=822,165); authors' compilations

pacemakers'. The first one specifies the time when the locality is abandoned or occupied. The second one describes the duration of the inhabitants' presence or absence. Pacemakers constitute stable sources of particular rhythms and we can identify various institutions, activities or structures that set the timing for a given urban environment. For instance, the hospital grounds are likely to define the morning peak in several grids within the 'Morning chronopolis'. The culmination of mobile phone localisations in morning hours is probably caused by the start of office hours with the highest number of patients waiting for examination. Another institutional pacemaker is the car factory (Volkswagen Slovakia) which is the largest employer in the Bratislava region. More than 10,000 employees are firmly bound by the work cycle of the factory, which manifested itself in the 'Work cycle chronopolis'. The same goes for the area of the oil refinery factory (Slovnaft) in the south-east part of Bratislava. The curve of this working type follows the morning and evening rush hour. Grids with a working type profile (A-shaped daily course) are most common, representing 30 % of the units under investigation.

The healthcare and industrial areas can be assigned as 'clock-time pacemakers', which are determined by specific time-space points to which phone communications must be adapted (e.g. working hours). The second type of pacemaker – 'event-time pacemaker' – expresses a certain minimal, typical or maximum duration of an activity. Such pacemakers are associated with socially delimited durations applicable to certain situations or activities (Mulíček et al., 2015, p. 311). In this view, the shopping malls exhibit as a dominant component of an overall rhythm of the 'Afternoon chronopolis'. The typical shopping session usually takes time in the afternoon, moving the peak period to 4:00–5:00 pm. The extended opening hours of shops, restaurants and pubs, in effect reflect the historical city centre.

In several parts of the city a particular pacemaker is not recognisable at first sight due to various overlapping rhythms. The mixed character of the given urban area, which involves residential and non-residential areas, is the unifying element of a relatively heterogeneous group forming the 'Mixed chronopolis'. In this type of rhythmic profile, mobile phone users accumulate in the morning and afternoon hours featuring peaks at mobile network infrastructure. The arrival of residents and departure of workers is probably the key factor of unique (overlapping) temporality. The outlying residential neighbourhoods, especially the satellite villages influenced by suburbanisation during the last two decades, express the inverse presence-absence polarity compared to the time profile of work-related types. The poorly developed amenities and almost exclusively residential character of such areas force residents to leave in the morning and return in the afternoon, forming the typical U-shape daily course of the 'Residential chronopolis'. There is a slightly different shape of the curve for the grids representing the areas of residential suburbanisation and the socialist-era housing estates of the outer city. A more significant decrease of mobile phone IDs during the day was recorded in newly erected suburban areas, which may indicate the limited work-related opportunities. Besides that, the formerly monofunctional residential areas of housing estates have established shopping and services and have become the target for small and medium-sized enterprises.

The rhythms of residential districts, however, are not described by 'Residential chronopolis' exclusively. Several grids have recorded temporality without significant peaks. This 'balanced chronopolis' is the consequence of very different urban structures and activities. In certain instances, the balanced time profile is probably the result of mutual contradictory factors. In this case, the urban grid constitutes of central parts of former satellite villages, massively urbanised

during the socialist era. Nowadays, these districts are formed from former rural parts with family houses, socialist-era housing estates and recently erected developments. Along with the housing, they provide various services and jobs and act as a secondary cores in the urban space. In the second group, the balanced daily course is probably the result of the low fluctuation of mobile phone users during the day. An example is a brownfield area neighbouring the locality of gardens and alternative housing. The common feature of these seemingly different urban environments is the absence of larger work-related institutions, which would be involved as dominant pacemakers.

Due to the complexity of human activity and the diversity of underlying driving forces, however, the examination of diurnal time use curves would need deeper analysis, including the monitoring of the mobile phone's trajectories throughout the day. It is also essential to acquire the prevailing function of every grid based on the empirical observation of employment structure. The Census in 2021 would be a great opportunity to test such a context.

5. Discussion and conclusion

Rhythmic patterns can be seen all around us, in all processes, including the everyday mobility of the city's population. One main objective of this paper was to develop a methodological procedure that uses the data from mobile network operators to analyse the rhythm of the city and to delimit temporally defined urban space as a typological category. This objective can be achieved by various analytical tools, most commonly at this time by call-detail-records of the mobile networks. In this paper we put forward an alternative approach that uses the longitudinal signalling exchange datasets of mobile networks, and converts them into the time-space localisation of city users in order to analyse the polyrhythmia of individual urban places (chronotopes). In order to test our approach, we used mobile phone data from Bratislava to analyse spatio-temporal differences within the city. The proposed workflow based on VLR data produces a replicable means for measuring temporal variation of differentiated urban environments. Our results show that a city's diurnal rhythm exhibits repeating temporal patterns along locally distinct spatio-temporal areas within the city (cf. Osman and Mulíček, 2017). Analysing the similarity of rhythmic profiles, we identified particular types of chronotopes, conceptualised as chronopoles. It is noteworthy that the differences between the urban places of high and low cell density (the granularity of cell coverage areas) have not weakened the ability to capture meaningful local-level rhythms.

The differences between particular chronopoles reflect the dispersion of the industrial and service sectors within the city area. Moreover, they correspond with the localisation of residential districts and their share of work-related functions. The rhythms of urban districts with dominant residential or industrial functions are characterised by the arrival and departure of large numbers of mobile phone users. Peak and off-peak periods correspond to the prevailing nature of the urban grid represented by the dominant pacemaker. The meaningful time profiles in a variety of urban contexts help to ensure that the proposed method for analysing urban rhythmicity is relevant across a wide range of spatio-temporal patterns and differences. The findings could provide a better insight with respect to our understanding of the daily routine of human activity and its geographical patterns in urban environments. Moreover,

gridded hourly records of mobile phone users can be useful as urban monitoring tools and provide straightforward input to several models, particularly transport, land use, economic and environmental models of the city.

The analyses presented here confirm the great research potential of VLR data exploration compared to the traditional CDR data sets. At a given time, the VLR records the cell-level locations of all mobile devices, both active and idle. The observation of VLR records thus provides an instantaneous description of the location of all mobile devices at cell level. Moreover, the importance of this data source in spatio-temporal analysis is likely to increase. This is due to changes in mobile phone usage. While in the past we have used it mainly for voice calls and SMS messages, currently this use is declining in favour of data services (social networks, instant chat, etc.) and the passive use of the phone (e.g. in various applications which do not require an active interaction).

Despite the above-mentioned advantages, there are specific issues associated with the identification of daytime and nighttime localisation. It is clear that these categories only loosely describe the work-related and home-related anchors of individual time-space pathways. In fact, they involve a very diverse manifestation of everydayness. An important area for future research is therefore how traditional qualitative data can be used together with big data, such as mobile network datasets, for overcoming the limitations of the latter (Kwan and Schwanen, 2018). There are several types of data that would complement or enrich the analysis of urban rhythms and extend the interpretation of mobile-network data. Monitoring of the mobile phone user's activity throughout the day would be helpful, but such tracking would require the active cooperation of the mobile subscriber (see Ahas et al., 2010). Valuable sources of data are also traffic counters, football sensors or video tracking, which can measure temporal movement in greater detail. Nevertheless, the records of the signalling exchange are a representation of the various rhythmicities of a given area. This ability is close to Lefebvre's polyrhythmicity – a concept of numerous urban entities shaping, modulating, and synchronising rhythms (Lefebvre, 2004). In this view, any analysed localisation of mobile phone users constitutes a simple example of extensive social, economic or biological rhythms.

As Sui (2012, p. 13) mentions, Hägerstrand's holographic world view is not a special way of formulating problems, but rather a special way of forming an image before any questions can be asked. In this view, the massive amounts of data from the mobile network infrastructure (and various social media sites) are building a complex image of everydayness, but our research methods and analytical power are insufficient to generate more appropriate questions and answers. Yet, there is an urgent need to develop more robust data analysis and synthesis methods for studying time and space dynamics.

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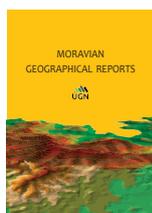
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Travel diaries, GPS loggers and Smartphone applications in mapping the daily mobility patterns of students in an urban environment

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Abstract

Mapping the daily spatial mobility of university students in an urban environment is the focus of this paper. It uses the city of České Budějovice in the Czech Republic as a case study, employing three different research tools – travel diaries, GPS loggers and Smartphone applications. We focus our attention on the analysis of spatial patterns of mobility using basic mobility indicators (distance, number of daily trips, time spent mobility), travel behaviours (use of transport modes) and the detection of time-space bundles (spaces of concentration of particular time-space trajectories) within the city. We identified four main time-space bundles. Then we compare the three main research methods according to their tracking accuracy and informative value. The Smartphone applications (using the A-GPS technology) provided the best results for the spatial mobility of respondents, although the travel diaries method is still unique due to the extent of some socio-demographic and transport characteristics.

Keywords: spatial mobility, travel diaries, GPS loggers, Smartphone applications, 3D visualisation, students, Czech Republic

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1. Introduction

Mobility is an intrinsic and integral part of most peoples' lives. Workers, managers, students, pensioners, tourists and most other groups of a population are currently characterised by a high level of mobility. By the realisation of various travels, people satisfy their living needs and wishes. The places whereby satisfying the essentials of life, however, have become more and more widespread in the last few decades. Thus, people are forced to travel longer distances and spend more time travelling than before (see e.g. Cresswell, 2006). Such growing mobility is typical for all parts of the world, even though rather large differences occur among them.

Traditionally, inhabitants of regions with a high degree of economic and social development show the highest degree of mobility; on the other hand, even in developing countries the level of spatial mobility has started to grow in importance (Gough, 2008; Adey, 2017). Similar trends can be also tracked down to the level of daily spatial mobility (e.g. Hjorthol et al., 2010). As a result, contemporary society

is frequently labelled as highly mobile and dependent on transport (Kaufmann, 2002). From such comments, it is evident that the world is becoming more and more mobile. A geographical point of view would stress the importance of the growing level of mobility, as it has a whole array of spatial associations and impacts (e.g. Kraft and Vančura, 2009).

This article has several objectives. The major goal is to map the daily spatial mobility of students in an urban environment using a case study of university students in the city of České Budějovice, Czech Republic. We focus primarily on the analysis of time-space mobility patterns and the identification of crucial factors in this mobility – a classical issue of research not only in transport or human geography (e.g. Urry, 2002; Novák and Sýkora, 2007). This topic is interesting primarily with respect to current changes in post-socialist cities connected to the growth of student concentrations, and the related social, cultural and economic changes in their internal structure (the so-called “studentification”: see Smith and Hubbard, 2014).

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University students are an interesting and important part of the urban population, although they are rather hidden in most official statistics. The second aim of this article is to compare traditional and novel methods of mapping spatial mobility through travel diaries, GPS loggers, and Smartphone applications. Whereas classical methods consisted of filling in travel diaries and subsequently analysing them using traditional methods of time-space mobility observation (e.g. Anderson, 1971; Janelle et al., 1988), modern methods are associated with the application of modern geo-information technologies (GPS loggers, Smartphones, etc.). Such methods then offer a distinct benefit in the opportunity to obtain a relatively large volume of information, which is moreover precisely localised (Novák et al., 2013), even though large differences exist in the informative value of the data so obtained. Hence, we strive to compare individual methods with respect to obtaining relevant information for the subsequent study of spatial mobility.

The results of the research can be used both in basic and applied arenas. Not only does the article highlight significant aspects of the spatial and temporal organisation of the student population in specific parts of the urban region, but it also analyses primarily the spatial patterns of the students' mobility with an emphasis on creating time-space bundles. In this study, we wanted to answer the following research questions:

- Are there any specifics of students' mobility compared to other population groups?
- What time-space bundles can we identify based on students' mobility in an urban environment?
- Which research method is the most suitable for mapping the students' mobility?

Therefore, the topic is not only important in human geography, but at the same time is also relevant for sociology, economics, cultural anthropology, and others. The research also has a significant application potential, primarily for urban planning and public transport planning, as well as for marketing companies. We follow a classical structure: this introduction is followed by a theoretical framing of spatial mobility issues, emphasising the changing forms of spatial mobility and opportunities to trace them through classical and modern research methods. The research design is introduced in the methodology section. The following parts analyse the time-space mobility of students in the city of České Budějovice, and primarily we accent the benefits and drawbacks of the chosen methods. The conclusion then contains a summary of the complete set of issues, including recommendations for subsequent basic and applied research.

2. Theoretical background

Mobility is a multi-disciplinary area of study. Processes related to the mobility of people are thus at the centre of interest of a variety of scientific disciplines, with geography, economics, sociology, cultural studies, etc. assuming leading positions (Kaufmann et al., 2004). Widely-interpreted spatial mobility is then one of key concepts of various sub-disciplines of Human Geography, especially transport geography in studying various aspects of spatial mobility in a complex form. Daily mobility is a relatively frequent topic in such disciplines (see for example: Timmermans et al., 2003; Scheiner, 2006; Klapka et al., 2014; Lefebvre, 2004; Mulíček et al., 2016; Kraft, 2014). For these reasons, we focus our attention on the recent development of spatial mobility and new research methods in this field.

An important inspiration platform of daily mobility research is based on time-geography approaches. The elements of this platform are related to the studies by Hägerstrand (1982) and the so-called Lund School scholars (Pred, 1981; Ellegård, 1999). Time-geography investigates the forms of individual mobilities in space and time, given that time and space are non-separable and quantifiable values that are fitting for the study of the socio-spatial organisation of society. One of the most significant applications of time-geography in practice is the research on the time-space activities of individuals, used for transport planning needs and the optimisation of transport processes within urban areas (e.g. Liu et al., 2015). Czech examples of the application of time-geography methods in studying the daily mobility of inhabitants are seen in studies of the suburban areas of Prague and in rural areas, addressed by Novák and Sýkora (2007) and Temelová et al. (2011), respectively.

Some of the most important factors that have an influence on the intensity, periodicity, level and reasons for daily mobility, are the conditionalities associated with the geographical environment. Some regions (rural, city, small town, suburban) may also be considered, given their distinctive socio-economic conditions and their effects on the level of spatial mobility and the demand for it. In this context, Pucher and Renne (2005) and Nutley (2005) state that the need for higher mobility is a characteristic feature of non-urban areas as the people living there are forced to satisfy their common everyday needs, as a rule, in towns and cities at a distance. Similarly, an increased demand for mobility can be seen newly exhibited in suburban areas where residents, in some cases, have to rely on services and other socio-economic activities located in the central towns (Jones et al., 2000). Urban areas are traditionally characterised by a relatively lower demand for spatial mobility, as especially in minor towns some activities are localised at a relatively short walking distance from residential districts. On the other hand, however, some authors note that urban regions in particular are often characterised by the highest rates of car ownership and the current urban way of living is commonly linked to the high frequency of spatial mobility and use of car transport (e.g. Jensen, 2009). The study by Novák et al. (2012) comments that traditional socio-demographic categories used in studying daily mobility (age, education, sex, etc.) are being overlapped by new distinguishing levels (lifestyle, individual life attitudes), which generally makes their interpretation more difficult.

A great attention of current mobility research is oriented to the study of individual mobility patterns. Their detailed study in recent years is possible due to the spread of modern geoinformation technologies capable of recording individual trajectories (mobile 'phones, GPS devices, location-based services, etc.). Mobility is very complicated and complex phenomenon, however. The results of particular studies differ significantly. Some of them confirm the expected increasing spatial dispersion of individual mobility associated with changes in the spatial organisation of society (e.g. increasing polycentricity of the settlement system: see Schwanen et al., 2001; Gutiérrez and García-Palomares, 2007). Also, Novák et al. (2012) in their study, confirm that the growing differences in mobility patterns are influenced mostly by lifestyle and individual preferences. On the contrary, there are many studies that confirm the relatively high regularity of mobility patterns (e.g. Kraft and Marada, 2017). González et al. (2008), for example, studied the mobility of 100,000 randomly selected individuals during a six-month period.

The results from this research showed that the monitored trajectories show a high degree of spatial and temporal regularity. Similarly, Song et al. (2010) concluded their research with the statement that more than 90 percent of human mobility patterns are regular and predictable.

In comparison, we note that individual mobility patterns are influenced by many factors. For example, Hunecke et al. (2010) state that individual mobility behaviour is influenced mainly by personal factors (accessibility of transport modes, socio-demographic aspects, lifestyle, etc.) and external factors (location of opportunities, the natural environment, transport policy, etc.). The interaction between these factors is then crucial for the emergence of complex mobility patterns. One of the most important factors affecting the intensity of daily mobility is then the distance over which people must travel to satisfy their living needs and wishes (Herder and Siehndel, 2012). This phenomenon is well known as the distance decay function (see for example, Halás and Kraft, 2016). This discussion can be concluded by saying that mobility is a crucial aspect of peoples' daily lives, with important social and spatial dimensions. Thus, we can better understand society and society-related processes through the study of mobility.

Travel diaries are one of the classical methods of data collection for the time-space mobility of respondents. Among their benefits is primarily the fact that they are able to provide a relatively broad volume of information on the individual trips of respondents, their time-space organisation and the transport behaviour of respondents, including very useful socio-economic parameters of individuals. On the other hand, the relatively low precision of recorded trips and the large time demands for the organisation and evaluation of individual travel diaries, are some of their drawbacks.

More recent studies dealing with practical time-geography applications point to a new era of research techniques in time-geography, which is directly related to the spread of information and communications technologies (Murakami and Wagner, 1999). Improved information and communication technologies (ICTs), widespread mobile communications equipment and satellite navigation systems entail new impulses for research in the field of daily mobility. Such research lies in the analysis of precisely recorded spatio-temporal mobility trajectories using the GPS technology (Novák et al., 2013; Šveda and Madajová, 2012). These studies, nonetheless, show that highly accurate data on mobility (GPS or cell 'phone records), combined with the traditional time-geography techniques (travel diaries, activity diaries), is ideal for mobility research at this time (e.g. Draijer et al., 2000; Kwan and Weber, 2010; Van Der Spek et al., 2009).

Given the recent rapid development of geo-information technologies, attention is, therefore, focused on using localisation data. Hence, recent studies frequently deal with spatial mobility analysis and transport behaviour of respondents using GPS loggers (e.g. Bohte and Maat, 2009), mobile 'phone applications (Abdulazim et al., 2013; Nitsche et al., 2014; Ouředníček et al., 2018), and, predominantly, using big data in the form of the location data of mobile operators (e.g. Widhalm et al., 2015; Calabrese et al., 2013). These precisely localised data provide important information on individual trips and their time-space organisation. GPS loggers and smartphone applications also feature some drawbacks – the difficulty in collecting and processing data files, including their conversion, the discipline of respondents in turning on/off instruments, etc. As a rule,

they are applied to selected samples of the population, which is associated with the need for additional aggregation of socio-economic data.

3. Data and methods

3.1 Geographical context

With respect to the above-discussed prospects and limitations of tracing spatial mobility, we use various methods and data sources. We trace the spatial mobility of university students in the city of České Budějovice, which is the regional metropolis of Southern Bohemia. As of 1st January 2018, the population of the city was 93,863. The urban population increases daily, however, by school pupils, university students, commuters, visitors, among others, etc. There are three university-type institutions in the city: University of South Bohemia (hereinafter referred to as USB); the Institute of Technology and Business; and The College of European and Regional Studies. In 2017, 14,864 students attended all the university-type institutions in the city. This situation underlines the fact that the city of České Budějovice is a significant and dynamically developing student city: i.e. the student population forms a significant part of the city population.

3.2 Research methods and data processing

For mapping individual mobility in the city, we used (i) travel diaries, (ii) GPS loggers, and (iii) localisation data through smartphone applications. For our purposes, the spatial mobility of 140 university students (74 female and 66 male) in the territory of the city of České Budějovice was analysed. The research included students from all the university-type institutions in the city. The structure of the sample corresponded to the typical structure of university students in the city with respect to their gender and age (see the official statistics by the Ministry of Education, Youth, and Sports – www.czso.cz). Our effort was to monitor the ordinary mobility of respondents on common working days. We wanted to avoid various limiting and distortion factors of their mobility (weather conditions, extraordinary situations, etc.). For such reasons, we always monitored the daily mobility of each respondent by all three methods, during four working days, in three different weeks. Due to the extent of the monitored sample, the field research was carried out in the period from October 2017 to May 2018.

The data obtained were subsequently geo-referenced and geo-coded. After the field research, data from the travel diaries were digitised for the analytical part of the work. At the same time, each respondent had on him/her a Holux M-1000C or Phototracker DPL 900 GPS logger on monitored days, which recorded his/her location. Given the battery duration (c. 17 hours), respondents were asked to turn them on immediately after waking up and turn them off at the moment they finished their last trip. Data from GPS loggers in the GPX format were then analysed in ArcGIS 10.5.1 and ArcScene 10.5.1 programs. The data collection using smartphone apps was organised in a similar fashion. Respondents downloaded the respective pre-selected application for recording the time-space location of their phones and turned it on for the given day. For the data collection from smartphones, the Geo Tracker (Android), Trails (iOS), and Sportrate (Blackberry) apps were used. The fact that they provide the user with data exported in GPX format is a significant benefit. Therefore, the data obtained could be compared immediately to data from the GPS loggers with no major adjustments.

4. Daily mobility patterns of students in the urban environment

The daily spatial mobility of individuals is influenced significantly by a large set of both objective and subjective factors. Therefore, each individual is a quite unique entity with specific traits of individual mobility. Nevertheless, it is obvious that certain similarities and concurrences occur with respect to the time-space organisation of university students' daily mobility (see Fig. 1).

During the entire research period, a total of 3,236 trips with a duration of more than 914 hours were recorded for all the respondents, who travelled more than 4,446 kilometres during these trips. That means that each respondent made on average almost six trips in one day (trips were differentiated as to their purpose); the average daily distance was nearly 8 kilometres; and students were mobile almost 98 minutes daily on average. When compared to information for the entire population in various regions in the Czech Republic (all age categories), it can be stated that the spatial mobility of students is extraordinarily high with respect to the number of trips, at shorter distances and, on the contrary, a longer time spent being mobile (see the comparison with Novák and Temelová, 2012, or Kraft, 2014). We assume that this results generally from

their usual time-space routines, without the need to take care of members of their households, lower requirements for mobility time aspects and other factors (see for example: Frantál and Klapka, 2020).

Higher values of mobility (the number of trips, distance and time) is more typical for women than that for men (see Tab. 1). These results can be supported by other statistical information (e.g. the standard deviation is similar for both sexes). These gender differences confirm results from other studies, for example Frändberg and Vilhelmson (2011). It can be assumed that the higher mobility of women is influenced by their more active use of space, the higher spatial dispersion of their daily activities, or by selecting a route that is not always the shortest trajectory between two locations (compare, say with Klapka and Roubalíková, 2010). Also, the speed of movements differs by gender, with a higher average speed typical for men (5.14 km.h^{-1}) compared to women (4.82 km.h^{-1}). These differences are influenced mainly by the differences in the use of transport modes (see below).

It is obvious from the completed travel diaries that pedestrian, bicycle and public transport are the dominant transport modes. This is particularly influenced by the lower levels of car ownership, the relatively small size of the city allowing easy accessibility to the majority of routine

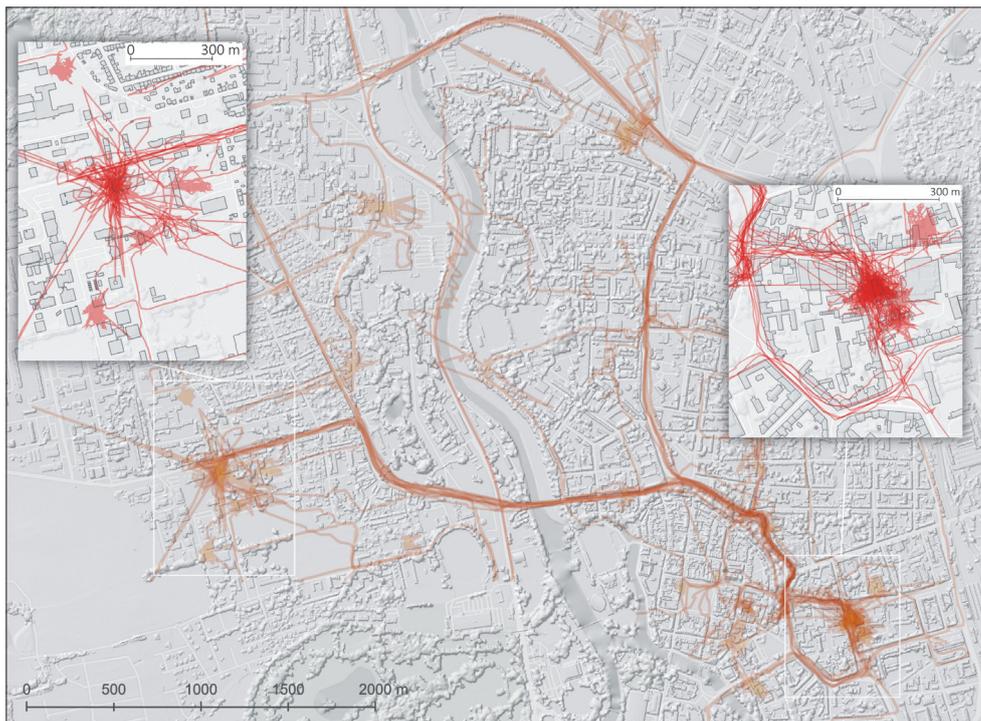


Fig. 1: Visualisation of selected trajectories of spatial mobility of university students within the city ($n = 140$)
Source: authors' field research

	Whole sample	Average per student	Average for female students	Average for male students
Number of trips	3,236.0	5.78	6.01	5.42
Duration (min)	54,852.0	97.95	102.41	90.69
Distance (km)	4,446.3	7.94	8.24	7.76
$n = 140$				

Tab. 1: Basic indicators of spatial mobility of university students ($n = 140$)
Source: authors' field research

destinations on foot or by bike, with a lesser need to organise the trip time (see e.g. Kamruzzaman et al., 2011; Klöckner and Friedrichsmeier, 2011). This is shown in Figure 2. It is quite evident that the students' spatial mobility is strongly tied to the transport modes' accessibility. Whereas the bike and pedestrian transport modes are more used during the day, public transportation and taxis are relatively more used in the evening and during the night? Moreover, these transport modes are more used, as shown in the travel diaries, for random/irregular trips.

From a spatial point of view, a significant concentration at individual stations is one of the basic attributes of the students' mobility. Visualisation of individual mobility trajectories of students indicates a straightforward concentration at stations associated with routine activities of students (university, campus, city centre, shopping centres, sports fields and others.). Figure 3 shows the spatial

attributes of students' mobility in the city during a working day, using 3D visualisation for selected trajectories on 9th April, 2018. The key finding is, of course, that the places of concentration of individual trajectories more or less differ with respect to their time organisation. Therefore, individual mobility trajectories tend to converge in certain time and space segments and, thus, create time-space bundles in which their everyday life is concentrated (Miller, 2005). Thus, the phenomenon arises when several individuals share almost identical activities at a certain time and in one place, a similar finding to Shaw and Yu, 2009. In our research, the time-space bundles were defined according to the following criterion: A time-space bundle was a place where at least 15% of the respondents concentrated in an area of 100 square metres within one hour. The time-space bundles defined this way can identify transparently the major places of time-space concentration of students in the city.

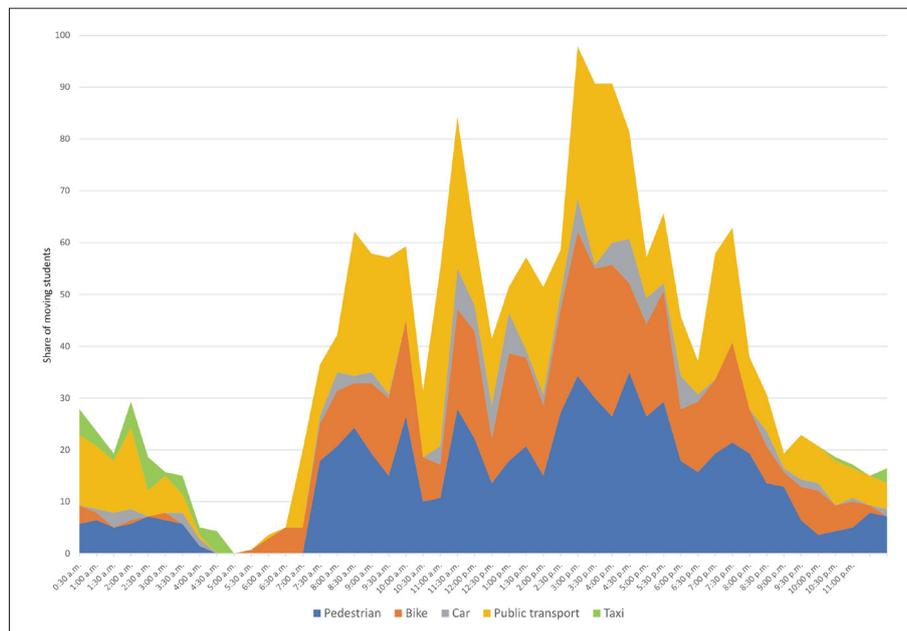


Fig. 2: Transport modes used by students within the city (all monitored days)
Source: authors' field research

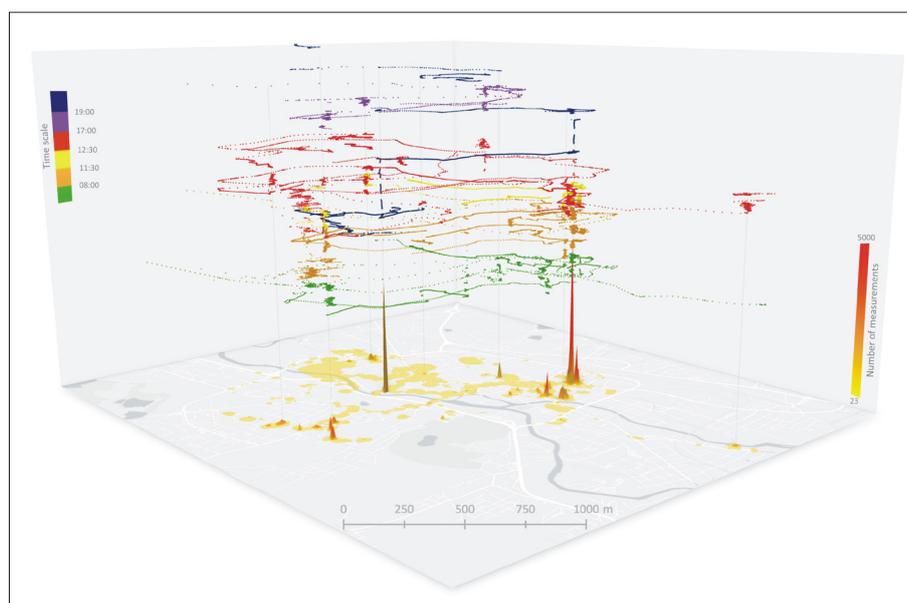


Fig. 3: 3D visualisation of selected trajectories of spatial mobility of university students within the city (9th April, 2018)
Source: authors' field research

In the environment of the city of České Budějovice, four locations – the University campus of USB, the Faculty of Education of USB, the IGY shopping centre, and a less specific area in Senovážné náměstí in the city centre – became the major time-space bundles defined in this way. The first two bundles play a key role in the life of students. Within the University campus, there are student dormitories (with an accommodation capacity exceeding 2,000 units), the university canteen, a library, and the majority of USB faculties. Therefore, the majority of students' routine activities occur in this bundle. The Faculty of Education of USB is the largest faculty in the city in terms of the number of students; therefore, it is logical that it becomes an important time-space bundle in the city organism, with a distinctly different concentration of students during the day. Both of these bundles represent a space for the activities of women and men alike. The IGY shopping centre, one of the largest shopping centres in the city, is the third major bundle. Its major benefit consists in its easy accessibility from other bundles, as this shopping centre is located close to the broader city centre (Šilhan and Kunc, 2019). This bundle, however, indicates a relatively specific time-space concentration of students – here, there is an evident preponderance of females, and the major student activities (primarily shopping and entertainment) are concentrated predominantly in the late afternoon and evening hours. Senovážné náměstí, near the historical core of the city, is the last bundle in the students' time-space mobility. In this bundle, the concentration of the students' time-space activity is the lowest, without any distinct irregularities. It can therefore be assumed that the reasons for individual trips differ in this area. This locality is significant because of its proximity to the historical centre and the presence of pubs and entertainment facilities; at the same time, it is one of the key transfer points in terms of public transportation in the city. Activities realised in this bundle are, therefore, of a different nature and relate to both women and men, as reported similarly by Kenna (2011).

5. Comparison of research methods

The second major objective of this article is to compare individual research methods – travel diaries, GPS loggers, and records from smartphones. The specifics of individual methods have been indicated above, including their major benefits and drawbacks. In this section, we will try to compare these methods with respect to their precision and the validity of the information obtained. We carry out this comparison with a detailed analysis of the time-space mobility of several respondents. When the whole sample is evaluated, some of the significant aspects, primarily the precision of the information obtained, will remain hidden (Licoppe et al., 2008; Montini et al., 2015). For an illustrative and as clear as possible presentation of the results, two respondents were chosen under their codes 12M and 16Z. The choice of these two respondents is justified by our intention to obtain a comparison of students as different as possible with respect to their characteristics.

Respondent 12M (a male) is a student at the Faculty of Education of USB. The record on his time-space mobility was obtained on Wednesday 11 October, 2017. On this day, the time-space mobility data collection process was subjected to tracing by all three methods, i.e. travel diaries, GPS loggers, and mobile phones. The travel diary was filled in according to the given criteria. All digital data obtained through the GPS logger and the male respondent's personal

mobile phone were faultlessly stored and sent for processing. The respondent's personal mobile phone featured the iOS operating system and his time-space mobility was recorded using the Trails application. The 12M respondent's spatial mobility consisted of eight trips he made within the time span from 7:25 to 15:10. The second respondent, a female, was chosen under the code 16Z. She was a student of Faculty of Economics at USB. The record on her time-space mobility was obtained on the same day. Her travel diary was completed in compliance with the given criteria, and the same was done for obtaining digital data via the GPS logger and her personal mobile phone, which featured the Android operating system, and her time-space mobility itself was obtained via the Geo Tracker application. 16Z's space mobility consisted of five trips she made in the time span from 9:30 to 17:35.

Figures 4 and 5 show clearly that several differences occurred in the record's quality when both respondents were traced using all three methods. In the travel diaries, respondents filled in the route of the given trips (indicating the streets they went through). It was the individual respondent's responsibility as to how they put this information into their travel diaries. We tried to reconstruct a possible route recorded in this way; however, it was almost impossible regarding the response quality. Therefore, we focused on a more substantial evaluation of differences in the records' quality from GPS loggers and smartphones. These differences are primarily caused by technological dissimilarities in the data collection process.

While the signal from the GPS logger recorded the respondent's position with a lower number of points, the signal from the smartphone was more frequent as far as the number of logged points is concerned (see the comparison of number of points, distance travelled and the divergence between GSM and GPS records in Tab. 2). The reason for this consists in the fact that a GSM (based on the A-GPS technology) logs the respondent's position when any signal is picked up (mobile data, Wi-Fi networks and others.). Also for this reason, recordings from smartphones can be considered more precise. The biggest problems in recording the time-space mobility of the students occurred when the respondent stayed in buildings for a longer time. In buildings, frequent loss of and searching for a signal occurred (the so-called "urban canyoning effect": Gong et al., 2012). As a result, the search for a signal occurred automatically again and tended to generate multiple position data in the vicinity of one place. This was most obvious in the vicinity of individual stations of respondents (generally at home and at school). Multiple recordings of position occurred in both tracing methods. It applies however even in this case that more precise recording (with a lower number of multiple points) is typically provided by smartphones. On the contrary, GPS loggers (without A-GPS technology) had a general tendency to generate more points in one place, which significantly affected the resulting movement trajectory. In such a case, most researchers choose either manual or automatic selection of such points and their reduction for smoothing individual trajectories (Šveda and Madajová, 2015). These corrections are then necessary also in the case of data from smartphones but, of course, on a much lower scale.

In addition to these differences, partial variations of positioning points occurred on passable lines, which is again the result of the above-mentioned 'urban canyoning' effect. Although precise localisation of respondents obtained from a smartphone or GPS logger is very important in time-space mobility research, it still lacks some important aspects

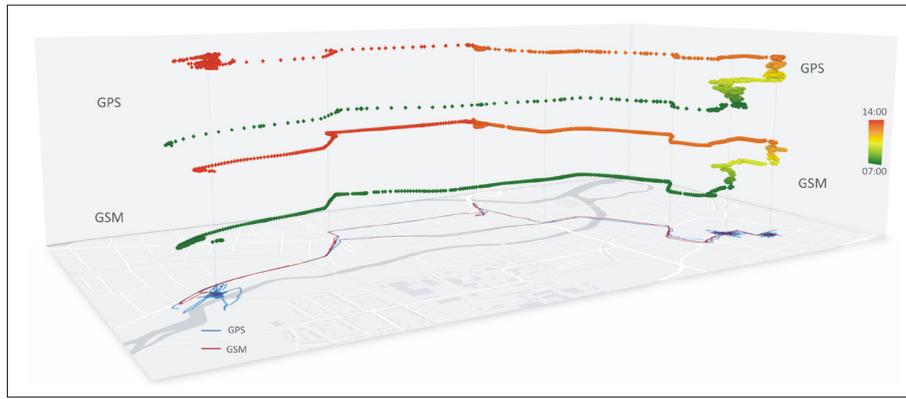


Fig. 4: 3D visualisation and comparison of the trajectories of spatial mobility of respondent 12M within the city
Source: authors' field research

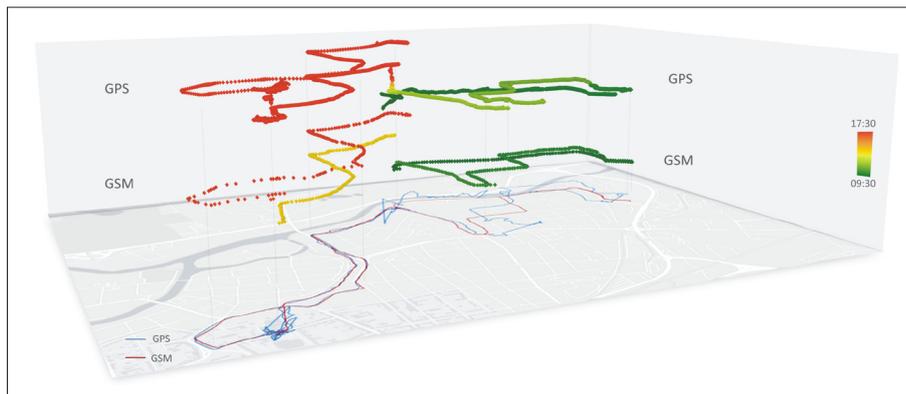


Fig. 5: 3D visualisation and comparison of the trajectories of spatial mobility of respondent 16Z within the city
Source: authors' field research

User/record	Points	Distance (m)	Divergence GPS on GSM	
12M – GSM	2,454	9,288.74	Mean (m)	Median (m)
12M – GPS	5,443	23,718.52	6.75	4.8
16Z – GSM	634	8,869.08	Mean (m)	Median (m)
16Z – GPS	28,179	16,731.94	4.62	1.95

Tab. 2: Basic features of GSM and GPS records (respondents 12M and 16Z)
Source: authors' field research

identified through travel diaries. Among the most significant pieces of information are the key socio-demographic characteristics of respondents, transport mode, social context of the mobility and other factors. Some research projects are, therefore, focused on eliminating these limitations by, for example, automated identification of the transport mode (Gong et al., 2012; Xiao et al., 2015; Wu et al., 2016) by interconnecting the records with transport networks and an analysis of average speed. The absence of such data, however, remains an unresolved issue in current mobility studies.

6. Conclusions

University students are a significant group of the urban population. The general growth in the number of persons studying at universities in urban regions generates new research topics. Among significant topics is the study of student mobility patterns that are applicable in both basic and applied research. It was ascertained in the article that

the mobility of university students features some traits (greater number of trips, more time spent on travelling, greater time dispersion and so on) compared to other population groups (Hjorthol et al., 2010). The time-space concentration of mobility into individual bundles is then a specific representational device. Individual bundles are given by the identical organisation of some student time-space mobility routines. Among the most significant bundles of the students' time-space mobility are the university campus, the city centre, shopping centres and other locations. These places play a crucial role in students' everyday activities within the city, and their mobility patterns are substantially influenced by accessibility to transport modes. The use of transport mode differs strongly according to daily time and other specifics. The specific concentration of students within the urban environment brings important findings for policy makers (spatial planning, public transport planning) or taxi services (main origins/destinations within the city, including their time-space organisation).

The application of various approaches and methods in the research of time-space mobilities of inhabitants is a key prerequisite for extending the borders of this field. The tested methods are unique with respect to their procedures and performance. Therefore, it is impossible to provide a clear-cut verdict which would fully reject or highlight any one of the methods. A significantly more important step is to find a certain intersection across these methods, and, thus, reach an instructive recommendation or guideline for their application in the future. Only a well-chosen combination of all the methods used for collecting time-space data can lead to the required but, primarily, comprehensive results. The questionnaire method offers a value so far unsurpassed in information dealing with the use of modes of transport, trip purpose, and trip periodicity. In the case of a study focused on the nature of smaller groups or households, this method represents an irreplaceable way of bringing exactly targetted knowledge about the studied sample (Novák and Temelová, 2012). In the case of working with digital recording devices, it is necessary to be aware of the helpfulness of the observed sample of the population for these achievements of modern science. The mobile phone method proved itself well in the research of the time-space mobility of university students in České Budějovice and was fully functional in all the cases observed. The GSM records bring more accurate and consistent data. This positive result, however, should not be relied on in all future studies in the topic of time-space mobility observations. Primarily, in a population with a higher age limit, it is necessary to expect major problems when using any technique in the field where there is a lower usage of smart devices. Nevertheless, prospects for improvements in this situation within the overall population are more than favourable. Here, the major benefit, in comparison with other methods, lies with GPS loggers. This benefit is primarily represented by an absolute simplicity in relation to respondents. With the use of modern loggers, much better results in recording time-space data can be envisaged than those presented in this work (Van der Spek et al., 2009). Notwithstanding the financial demands of this method associated with purchasing devices, this way of collecting time-space data has a great potential to include this population group.

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A tale of two cities: The comparative chrono-urbanism of Brno and Bratislava public transport systems

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Abstract

Time policies in urban environments are discussed in this article, including some difficulties in comparing such policies between cities and in an international comparison of urban times in general. In response to the need to systematise methodological approaches to the comparison of urban time policies, we offer a concrete solution in terms of a comparative chrono-urbanism. The main issues under consideration are the theoretical framings, systematic procedures and an empirical illustration comparing two urban times. The comparison serves as a tool for assessment, when one urban time becomes a criterion for another urban time. This approach is applied in the case of an international comparison of two similar cities – Brno (Czech Republic) and Bratislava (Slovak Republic). Their urban times are operationalised through the timetables of their public transport systems, the lines of which are conceived as the institutional carriers of urban time. Based on the analysis of timetables from 2016, we present a detailed description of urban times of Brno and Bratislava, as well as their comparison, which makes it possible to assess the time policies in both cities, as well as their implications for planning.

Keywords: time policy, urban time, comparative chrono-urbanism, urban planning, Brno (Czech Republic), Bratislava (Slovak Republic)

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1. Introduction

Following the Italian school of urban time planning and the French school of chrono-urbanism, this article discusses time policies. It responds to a situation when current academic research often describes urban time for only one city or offers a time comparison of several locations within one city but does not compare the times of different cities. This situation is interpreted as a lack of systematic methodological procedures, which would make the comparison of urban times possible. To answer this need, the authors set three goals in terms of theory, methodology and an empirical case study. At the theoretical level, this paper intends to conceptualise urban times in a way that enables mutual comparability of different urban times. Methodologically, a way to systematise comparison of the urban times of multiple cities during one moment in time, or one city in various time periods, is presented. To achieve these goals, we use a spectral analysis of rhythms, which is adapted for the comparison of the rhythmic profiles of institutional carriers of urban time. At the empirical level, the study aims to apply our approach in comparing the urban times of the cities of Bratislava (Slovakia) and Brno (Czech Republic).

Urban time is operationalised through the timetables of the city public transport systems, the lines of which are seen as the institutional carriers of urban time. The text thus describes the urban times of Bratislava and Brno, comparing them mutually, and shows how the approach of “comparative chrono-urbanism” makes it possible to assess the urban time of one city by the urban time of another city. This approach can contribute to a better understanding of time public policies applied in cities, and the importance of time policy and urban planning of city space in general. At the level of policies, the text follows some of the broader goals of chrono-urbanism, which criticise solely spatial tools of urban planning, and contributes to efforts at understanding “timing”, or the common planning of city spacetime.

2. Comparative chrono-urbanism

2.1 Time-geography and the multiplication of time

The traditions of time geography inform our approach in this research and follow the original assumptions of the

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Lund School. It nevertheless reflects the enormous shift that interest in time has experienced in geography since its earlier renown in the 1970s and 1980s. The tradition understanding local time as one of the most basic defining characteristics is rooted in the very origins of the Lund time-geography. Abandoning a homogeneous, universal, linear and somewhat “abstract” time and replacing it with local, heterogeneous, meaningful, fragmented discontinuous time, or the multiplicity of times, is linked to the so-called chrono-geography. Thrift and Parkes noticed that spacetime is not the same everywhere, but changes in its dependence on location and time. Instead of abstract spacetime, they proposed a so-called timed space, i.e. space formed by the way time is treated within it (Parkes and Thrift, 1978, p. 119). Timed spaces are structured by time into distinct locations (Parkes and Thrift, 1978, pp. 121–129). According to these authors, chrono-geography thus represents a more general concept than time-geography; time-geography is seen as a partial approach working only with abstract time and abstract space (Rämö, 1999).

In comparison to time-geography, chrono-geography is broader and encompasses all kinds and forms of time and space conceptions (Parkes and Thrift, 1980, p. 9; Harmoinen, 2003, p. 10). They also introduced the concept of para-time, which is understood as a kind of meta-time or super-time stressing what is common for all time conceptions. From this meta-time, various temporalities are derived, such as universe time, life time, social time, biological time, psychological time, etc. (Parkes and Thrift, 1980, pp. 36–105). Thus, the universal status of abstract time is destabilised, and geography begins to perceive it critically as a concept which can take various forms. It ceases to be seen as one abstract time: there are many times and not all of them are one-way and linear flows. In such a situation, the conception of time is pluralised and times of very different forms can co-exist (hetero-temporality, multi-temporality, polyrhythmicity: see Hutchings, 2008; Klinke, 2013).

2.2 Urban time in Italian literature

In this paper, we focus mainly on one kind of time – urban time. This concept has been developed during the feminist struggle for a more equal temporal organisation of cities at the turn of the 1980s in northern Italy, when the feminist movement responded to dual lives and their temporal incompatibility. The concept of urban time is thus rooted in the conception of a double presence, which pointed out that women had to live two mutually separated lives: maternal life and work life (Balbo, 1978). The lack of coordination of these lives creates many temporal problems, barriers and conflicts, which affect a large part of society and are not treatable at an individual level. To solve this incompatibility of double lives of (not only) women, time policy started to use two different time concepts – urban time and social time. While the former describes societal timing of cities through institutions (opening and closing hours, lunch and other breaks in offices, schools, hospitals and shops, etc.), social time defines the temporal behaviour of urban society (socially established holidays, rituals, customs, traditions such as everyday getting up, eating, working, learning, shopping, etc.). These two conceptions of time, set in opposition to each other, enable us to capture moments of temporal incompatibility, when the social time of city dwellers cannot be linked to the urban time of city institutions (Bonfiglioli, 1997; Belloni, 1998; Mareggi, 2002). In this article we will not utilise the concept of social time, limiting our analysis to the concept of urban time. Most frequently,

geography uses urban time when studying the temporality of urban retail (Kärholm, 2009, 2012; Kärholm et al., 2017; Fernandes and Chamusca, 2014; Mulíček and Osman, 2018; Osman, Mulíček and Seidenglanz, 2019), or city public transport (Mulíček, Osman and Seidenglanz, 2015, 2016). We follow in the steps of the second group, and study urban time represented by public transportation. This is, however, a decision for the purposes of this paper only. The use of our procedures is not limited to urban time in the form of public transport timetables, but can also be used for different concepts of urban time (retail opening hours, water consumption, electricity consumption, intensity of electronic transactions, etc.).

2.3 Chrono-urbanism in French literature

Chrono-urbanism can be regarded as one of the most influential time policies. Time policy or a policy of time has been gradually established mainly in European states. Nevertheless, chrono-urbanism is typical for southern European countries, such as Italy, France, Spain or Portugal. Drawing on the experience of Italian cities, it has developed into the form of time policy and the time government of cities mainly in France, where it is linked with the work of François Ascher and Luc Gwiadzinski (within the expert discourse of Geography) and at present, it is actively used by the current Mayor of Paris, Anne Hidalgo, in the form of Plans for the “City of fifteen minutes” (Ville Du Quart D’Heure). The above-mentioned authors point out that urban planning is realised mainly through space tools such as the zoning plan, the regulation plan or the building permit, while most of the problems of contemporary city communities stem from temporal uncertainty, its transfer to the individual, the creation of individual strategies “just-in-time”, and the simultaneous management of multiple tasks. Therefore, Ascher calls for temporal planning and city time policy, saying:

“Public authority has a triple role in this area: it has to ensure equal access to public services for city inhabitants, who tend to have a more atypical and irregular time schedules. It has to offer or enable collective services that make it possible for economic activities and individuals to develop new rhythms and time schedules. And finally, it has to coordinate, or regulate private temporalities in the name of general interest, maximisation of external savings and fight against inequality.” (Ascher, 1997, p. 121)

As time policy, chrono-urbanism thus tries to respond to the social inequalities connected to the general speeding up of society, the irregularity of everyday activities, uncertainty, an unforeseeable future, difficulties in planning, time stress, etc. (Ascher, 1997, 2001, 2008; Gwiadzinski, 2014, 2015; Drevon, Gwiadzinski and Klein, 2017; Gwiadzinski, Maggioli and Straw, 2018). More generally, through the “timing” of contemporary tools of urban planning, it tries to deal with current social problems stemming from various forms of colonisation and the privatisation of times of city dwellers. For the purposes of this paper, chrono-urbanism is thus seen as policy dealing with urban time.

2.4 Internationalisation of time policies and comparative chrono-urbanism

The existence of a plurality or heterogeneity of diverse times offers the possibility of their mutual comparison. Most often, the times of different localities, usually within one city, are compared in this context (Wunderlich, 2007, 2008, 2010a, 2010b, 2013; Pafka, 2013; Osman and Mulíček, 2017).

A whole range of studies compares times of different cultures, societies or states. It is also possible to refer to comparative studies of religions (Laguette, 2003, 2004a, 2004b, 2007, 2010) or comparative studies of the societal meaning of time for different nations of the world (Levine, 1997). Less attention has been paid to comparing times of different cities. In this context, Lefebvre's work on Writing on Cities has been of crucial importance, comparing the rhythmicity of Mediterranean and Northern European cities (Lefebvre, 1996). Lefebvre's analysis was not based on urban times, however, but on the "ensemble of rhythms" (Lefebvre, 1996, p. 230). Studies that compare the urban times of different cities are rare (Johansson and Kociatkiewicz, 2011; Schwanen et al., 2012; Kärrholm et al., 2017), as well as those comparing urban times of one city in different times (Muliček, Osman and Seidenglanz, 2016) or different cities in different times (Cochoy, Hagberg and Canu, 2015). This can be partially attributed to the great heterogeneity of urban times, their local specificity and difficult comparability. Nevertheless, some texts attempt at such a comparison, and their essential source of inspiration is the "spectral analysis" of individual temporal components of urban time posited by Mike Crang:

"A multiplicity of temporalities, some long run, some short term, some frequent, some rare, some collective, some personal, some large-scale, some hardly noticed – the urban place or site is composed and characterised through patterns of these multiple beats." (Crang, 2001, p. 190)

This approach has been used, for example in comparing the urban times of Angers, Lisbon, Malmö and Porto, working with the opening times of shops (Kärrholm et al., 2017), and for the comparison of urban times in Brno city in 1989 and 2009 (Muliček, Osman and Seidenglanz, 2010, 2016), which used public transport timetables. None of these studies, however, attempted to use a systematic unified approach comparing the urban times of "different" cities. Such a systematic approach could increase the number of studies and highlight the role of chrono-urbanism for contemporary urban communities. In this article, we respond to this situation and introduce a methodological approach that facilitates the systematic comparison of two urban times (either times of two different cities, or one city at different times), which we call 'comparative chrono-urbanism'.

3. Methodology

At the theoretical level, this article is framed by the concept of urban time. The main question is: In what way it is possible to compare the urban times of different cities, or what options for comparison are offered by the concept of urban time. What can this comparison tell us about each of the cities, their temporalities and ways of life? These questions are then formulated into a unified goal, trying to conceptualise the city as a temporal unit, which can be described and compared with other cities based on their temporal characteristics.

At the methodological level, the research is constituted by comparative methods and spectral analysis. It consists of a description of the urban times of two selected cities, which are subsequently decomposed – using spectral analysis – into respective urban rhythms, and urban times are compared at the level of these rhythms. Methodologically, the paper tries to answer the questions of how the spectral analysis of urban rhythms can be used for comparison of urban times, how urban times can be decomposed into urban rhythms

and how these rhythms can then be compared. Under these explicitly formulated research questions, there is an implicit methodological goal to describe and illustrate by practical examples the application of spectral analysis for the comparison of the urban times of two (or more) cities.

At the empirical level, the comparison concerns the urban times of two concrete cities – Brno (Czech Republic) and Bratislava (Slovak Republic). For the purposes of comparison, two relatively similar cities were sought, so that they could be compared, yet different enough, so that certain differences in their urban times could be identified. These criteria were fulfilled by the capital city of the Slovak Republic – Bratislava, and the second largest city of the Czech Republic – Brno. Both cities are located in a similar cultural and geopolitical context, they share some part of common history, they used to co-exist in one state, they are of similar size (in 2017, Bratislava had 422,000 inhabitants and Brno 378,000), and their mutual distance is only 130 kilometres. On the other hand, there are many differences stemming from the fact that the cities have belonged to different states since 1993, and Bratislava became the capital of the newly established Slovak Republic at that time.

The two selected cities are compared using the concept of urban time. For the purposes of this study, urban time was operationalised as the form of the temporality of public transport connections in Brno and Bratislava. This choice was primarily motivated by pragmatic reasons, such as the comparable size of the two public transport systems, the public availability of data about timetables and connections, and mainly the comparable structure of the data. Of course, urban times of the two cities could have been compared using data from other institutions, such as the temporality of retail, schools, restaurants, etc. From the reasons mentioned above, the temporality of public transport was chosen.

The timetables of all public transport lines were processed, using the decisive time-point of September 1st, 2016 – the date on which both public transport companies updated their timetables in relation to the end of summer holidays and the beginning of a new school year. This date was selected to analyse a "normal" part of the calendar year, normal meaning a "secular", working, not-holiday part of the year. We worked with timetables of all modes of public transport (except ships and trains, even though these were part of the inner-city networks), namely the trams, trolleybuses, and buses. Neither of the two cities has an underground rapid transit system (metro). The initial analysis accounted for all tram, trolleybus and bus lines operating within the administrative boundaries of the respective city, and also lines having most stops within the city district, which connected nearby settlements with the cities of Brno and Bratislava. Lines with a majority of stops outside the administrative districts of Brno/Bratislava were not considered. Both day and night lines were analysed within this delimitation. Timetables were processed for working days as well as weekends, using a unified methodology for both cities.

In the case of lines which did not use day-specific timetables, the timetable for a non-specified working day was used. In the case of a line using day-specific timetables, only one day was used, in the following order: Wednesday, Tuesday, Thursday, Monday, Friday. Weekend timetables were processed in a similar way: in the case when a line did not specify weekend days, a general weekend day was used; in the case when it differentiated between Sunday and Saturday, only one of them was entered, in the order Saturday, Sunday.

Data constructed in this way were entered into the analysis with the empirical goal of answering the research question: “How does urban time in Brno differ from urban time in Bratislava?” The analysis consisted of spectral analysis of absolute as well as relative frequencies of daily connections. To obtain a general idea, the initial analysis also compared total aggregated numbers of all lines per hour in Brno and Bratislava, using absolute numbers.

Subsequently, a more detailed comparison was carried out at the level of individual lines, when the frequencies were relativised in relation to the total number of daily connections on each line. The relativised data were recorded in diagrams and grouped according to the mutual similarity in the distribution of daily connection shares, creating types with specific rhythmic profiles. In this way, all lines were divided into respective types, for each city separately. Subsequently, comparison of the urban times of the two cities was made, based on the representation of these rhythmic line types in each of them. The detailed results of this spectral analysis are stated in the following section.

4. Comparison of two urban times: The cases of Brno and Bratislava

The comparison of urban times of the selected cities through spectral analysis is made possible by the similar size of population in both cities, and also by the similar scope of their public transport systems. In a basic comparison, public transport in Bratislava shows somewhat higher numbers than the public transport in Brno: on a working day, it operates 33 more lines and 531 more connections than in Brno, and on a weekend day, it has 27 more lines and 769 more connections. In general, we can say that Bratislava public transport system is more extensive than that in Brno. The difference is larger on Saturdays and Sundays, when Bratislava provides 64.8% of workday connections, while Brno only 56.7% of workday connections. On a workday, Brno reaches 90.9% connections compared with Bratislava, while on a weekend day, it is only 79.6% connections (see Tab. 1).

A similar picture is rendered by comparison of the daily distribution of public transport connections. Again, it can be said that both cities are very similar. The distribution follows almost identical curves, both on workdays and on weekends. Only during weekends is there a difference in the absolute

number of connections in favour of Bratislava, for the daylight hours. The rhythm of a workday is almost identical, with two peaks and one gap. People in both cities awaken around 4:00 in the morning, they are awake very quickly, and the number of connections culminates around 7:00, forming not only the first peak but also the absolute daily maximum. Afterwards, the number of connections keeps falling until nine o'clock, when it settles to a continuous level lasting from 9:00 to 12:00. In the afternoon, the number of connections increases again until its second maximum at 16:00, gradually declining afterwards until it reaches its night minimum – which both cities have between 1:00–3:00 in the morning.

When comparing the rhythmicity of a workday in the two cities, we can identify several differences. Firstly, it shows that the light or active part of a day as construed by the activity in public transport is longer in Bratislava, mainly due to the evening hours. Whereas the waking-up in both cities has a similar speed, Bratislava “goes to sleep” more slowly than Brno. Simultaneously, Bratislava indicates higher absolute numbers of connections during both peaks, and lower during the noon gap. A mildly more balanced distribution of connections can be thus identified in Brno. The situation on a weekend day is different. The public transport systems of both cities show a similar distribution of connections with a homogeneous number during the whole day. Nevertheless, Bratislava starts its days off significantly earlier and finishes later than Brno. During the active part of the day, it also offers 30 more connections per hour than Brno (see Fig. 1).

A different picture can be drawn, however, if we differentiate the connections according to modes of transport. Public transport in Brno and in Bratislava is realised via three main modes of transport: trams, trolleybuses and buses. In both cities, the largest of these is bus transport, but its importance varies. Brno has a more proportional distribution of all modes of transport (bus 45%, tram 30%, trolleybus 25% connections) than Bratislava (bus 60%, tram 20%, trolleybus 20% connections). While the share of workday connections realised by buses between 4:00 and 22:00 in Bratislava does not drop below 50%, and approaches 70% during the peaks, its share in Brno is higher than 50% only between 21:00 and 22:00, while being only 35–45% of all connections per hour during the light part of the day. Bus transport on workdays also has a different

	Brno		Bratislava	
	workday	weekend	workday	weekend
Number of tram lines	11	10	9	8
Number of trolleybus lines	13	11	13	13
Number of bus lines	41	32	67	50
Number of night lines	11	11	20	20
Number of lines in total	76	64	109	91
Number of tram connections	1,607	882	1,011	641
Number of trolleybus connections	1,307	611	1,143	868
Number of bus connections	2,282	1,357	3,568	2,159
Number of night connections	102	156	107	107
Number of connections in total	5,298	3,006	5,829	3,775

Tab. 1: Basic comparison of public transport system size in Brno and Bratislava

Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

rhythm than other modes of transport in both cities. Trams or trolleybuses have a more balanced number of connections during the day, while bus transport is usually laid on in the two peak hours of working days – due to its easier

summoning and withdrawal. Interestingly, in Bratislava the higher number of connections in peak hours as compared to the noon gap is achieved with buses, but in Brno, trolley buses are used as well (see Fig. 2).

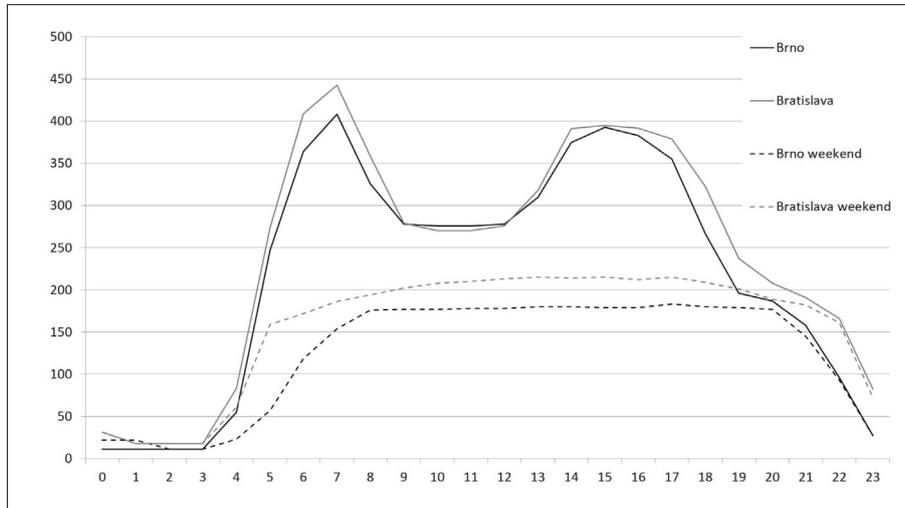


Fig. 1: The distribution of the total number of public transport connections in Brno and Bratislava during the course of the day. Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

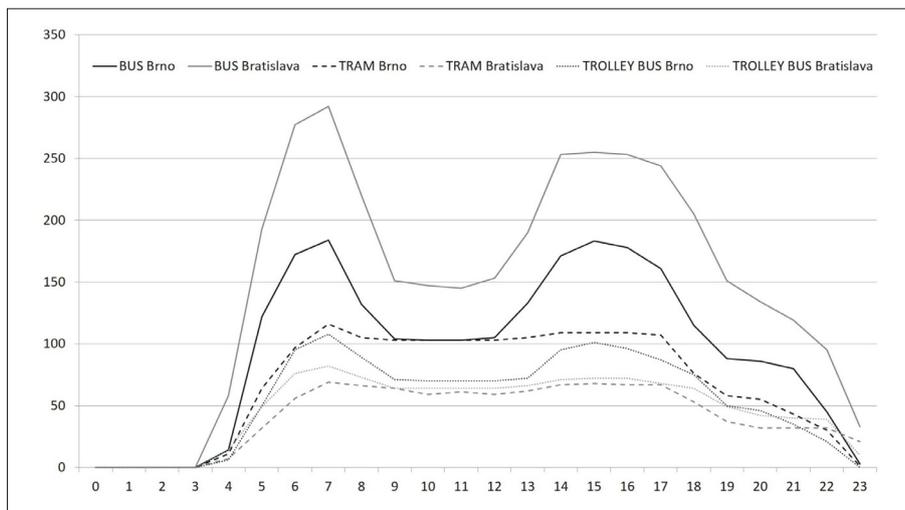


Fig. 2: The distribution of public transport connections in Brno and Bratislava on a workday – according to the mode of transport. Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

The distribution of connections on a weekend day shows a different picture. All modes of transport have a proportional distribution during the day and vary only in their share in the total number of connections. As stated above, Brno decreases the number of connections more significantly than Bratislava, which highlights some of the differences between the two cities. This trend, however, is only visible in the case of bus and trolleybus transport. Both of these modes reach higher numbers in Bratislava, during a whole weekend day. Trams go against this trend and show higher number of connections – with the exception of early morning hours – in Brno (see Fig. 3).

When analysing the spatial layout of the respective modes of transport, knowing that tram lines are materially connected to the central parts of both cities, it is clear that the above-mentioned statement about Bratislava having more connections on a weekend day is not true in

an absolute sense. There are more tram lines operating in Brno on a weekend day (10) than in Bratislava (8), which is also reflected in the number of tram connections – Brno realises 241 more connections (882 in total) than Bratislava (641). While it is true that weekend public transport services in Brno are less frequent in general, its central parts serviced by trams are not affected by this cut in the number of connections. In Bratislava, the total decrease in connections is distributed more evenly across the whole city area, and in Brno it affects its non-central parts to a greater extent (see Fig. 4).

This brings us to the relativisation of the absolute number of connections, i.e. to the density of connections, or more precisely, the frequency of connections in a given area. To describe this aspect of urban rhythmicity, we chose the indicator of the average number of connections per line. While Bratislava clearly outnumbered Brno in the

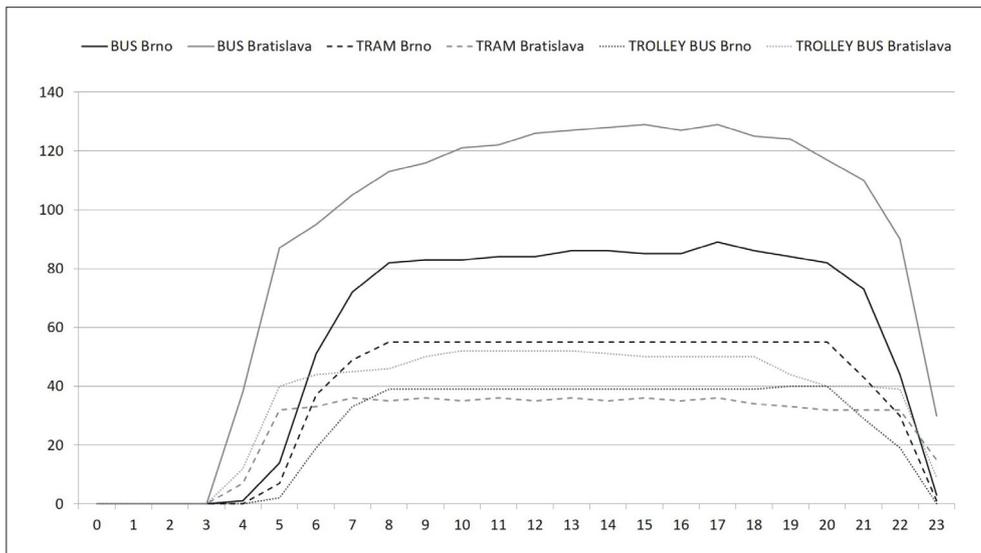


Fig. 3: The distribution of public transport connections in Brno and Bratislava on a weekend day – according to the mode of transport. Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

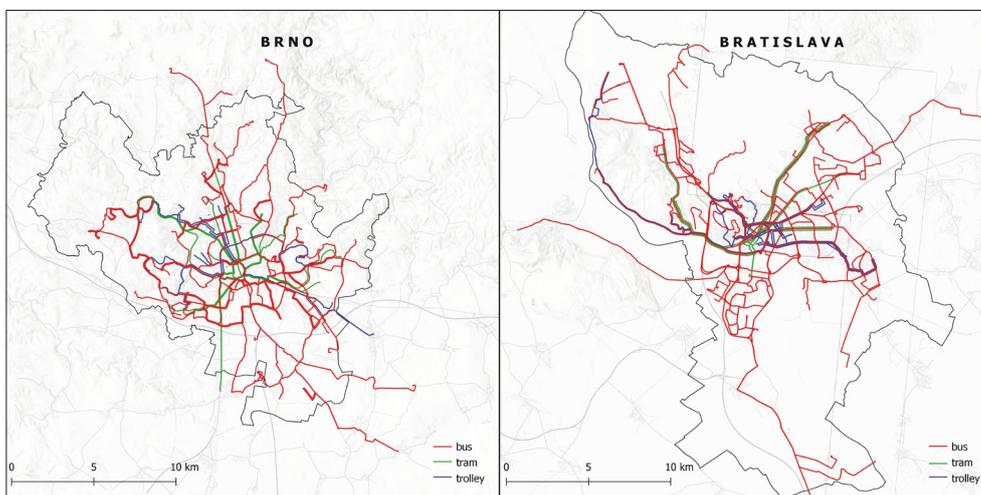


Fig. 4: The spatial layout of the modes of public transport in Brno and Bratislava
Source: authors' analysis

absolute number of connections, the number of connections per line shown by the relative indicator is higher in Brno. The disparity is higher on a workday, with Bratislava indicating the relative frequency of connections per line lower than Brno by 17 connections, while on a weekend day, this difference is only 6 connections in favour of Brno. On a workday, this difference is accounted for mainly by trams, with the average of 36 more connections per day per line, while on a weekend day, the difference in the relative frequency of connections can be ascribed to night lines.

Each city has a different organisation of night transport. Bratislava services use 20 nightlines, while in Brno it is only half the number; and in Bratislava, there is no difference between workdays and weekends as far as night services are concerned, but in Brno, weekend nights (or more precisely, nights before a day off) are serviced more frequently than workday nights. Generally, it can be summarised that Bratislava has a higher number of lines, which nonetheless have a lower average frequency of connections, both on workdays and on weekends (see Tab. 2).

	Brno		Bratislava	
	workday	weekend	workday	weekend
Average number of tram line connections	146	88	112	80
Average number of trolleybus line connections	101	56	88	67
Average number of bus line connections	56	42	53	43
Average number of nightline connections	9	14	5	5
Average number of connections per line	70	47	53	41

Tab. 2: The average number of daily public transport connections in Brno and Bratislava per line
Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

If we look at the distribution of the average number of connections per line, we can see that Brno does not outnumber Bratislava at all times of the day. In the morning and in the evening, the number of connections per line is quite even in both cities, but some lines in Bratislava have a higher frequency. The lines in Brno are serviced more frequently during the daylight hours. On workdays between 6:00 and

18:00, Brno public transport offers at least one connection more than Bratislava per hour on all its lines. The largest difference is in the afternoon peak hours – between 15:00 and 17:00, the difference is 1.5 connections per hour per line. During weekends, the higher frequency is reached mainly between 7:00 and 21:00, on average 0.5 connections more per hour per line (see Fig. 5).

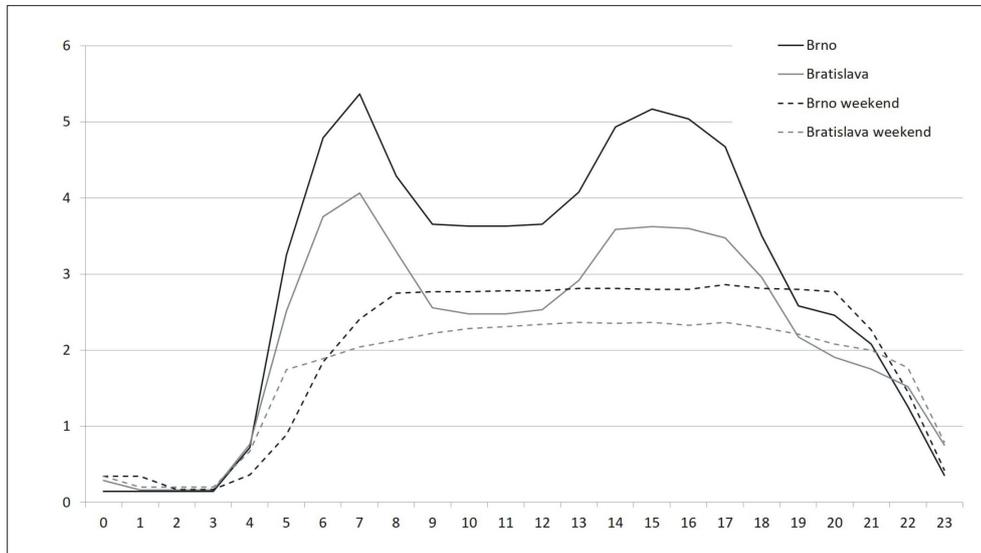


Fig. 5: The distribution of the average number of public transport connections per line per day in Brno and Bratislava
Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

Taking a more detailed look, both cities can be compared at the level of rhythmicity of their lines. A meaningful analysis, however, can be carried out only for workdays, when individual lines differ in their rhythmic profiles. Since there is a rather homogeneous distribution of all lines in both cities during weekends (Fig. 3), the rhythmicity of weekend days was not analysed. To be able to compare the rhythmic profiles of individual lines, the numbers of connections were relativised, counting the share (%) of connections operating on a single line in every hour (of the total number of connections at a given line). Due to the extreme fluctuation of low-frequency connections, further analysis considered only lines with more than 20 connections per day. This criterion ruled out 19 lines with the total number of 196 connections (3.7% of all connections) in Brno and 34 lines with the total number of 340 connections (5.8% of all connections) in Bratislava. Thus, the spectral analysis considered 57 lines of public transport in Brno and 72 lines in Bratislava.

The mere distribution of connections of all lines in both studied cities on a workday, however, did not bring results

that can be easily interpreted (see Fig. 6). That is why spectral analysis was made based on the comparison of the rhythmic profiles of individual lines. This analysis resulted in four rhythmic line types for Bratislava, and 5 for Brno. Thus, four ‘line types’ with a comparable rhythmic profile were identified in both cities, and one more line type – not found in Bratislava – was discovered in Brno. Some of the analysed lines did not match any of the defined profiles: in Brno, two lines with 90 connections (1.7% connections) did not correspond to any of the classified types, and in Bratislava, 4 lines with 101 connections (1.7% connections) could not be classified. Rhythmic profiles of the four identified line types found in both cities are shown in Figure 7. The types are labelled as peak (A), homogeneous (B), morning (C) and industrial (D). Their detailed description is given in Table 3.

The most frequent type, i.e. the type comprising most lines in both cities, was the type with the peak rhythm (A). A peak rhythm means two strongly formed peaks with a clearly visible gap between them, while the number of connections

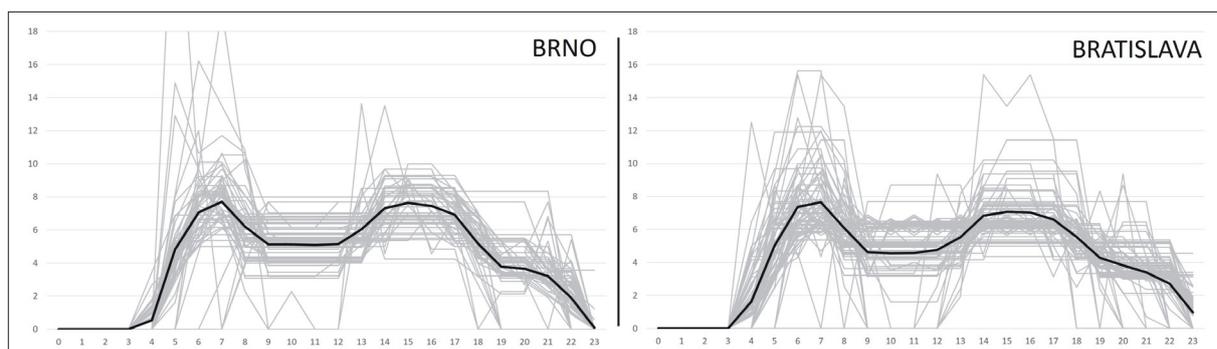


Fig. 6: The distribution of the relative number of connections of public transport lines on a workday
Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

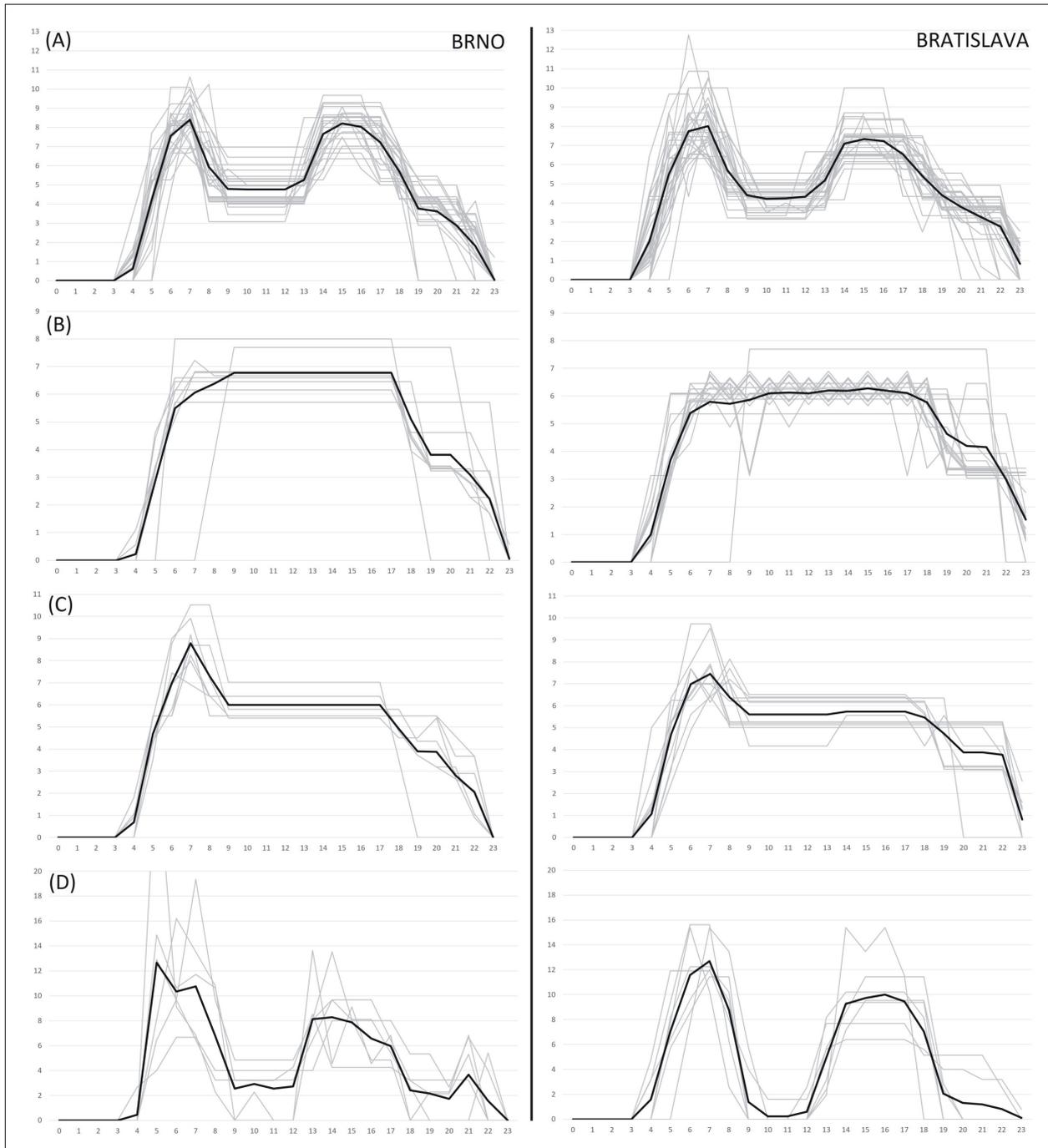


Fig. 7: The distribution of the relative number of connections of public transport lines on a workday according to line types (A – peak, B – homogeneous, C – morning, D – industrial)

Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

during the gap does not decrease more than by one half as opposed to the peaks. There are 27 peak lines in Brno offering 2,264 connections (42.7% of all connections) and in Bratislava, there are 31 peak lines offering 2,391 connections (41.0% of all connections). From the point of view of the dominant line type, it is possible to conclude that both cities have almost identical rhythmicity.

The second most frequent type was represented by lines with a homogeneous distribution of connections (B). These are lines with a flat long maximum during most of the daylight hours. Their rhythmic profile rises quickly to reach its daily maximum and keeps it for most of the day to fall in a relatively gradual way during evening hours. While in Brno, there are 10 lines with 1,094 connections (20.6%

of all connections) of type B, in Bratislava, it is 19 lines with 1,678 connections (28.8% of all connections). There is a significant difference between the two cities in this rhythm. In Bratislava, lines of this type are more common as far as their number and number of connections are concerned, and they have a lower frequency of connections (one connection less per hour than in Brno). They also tend to operate at a higher frequency longer in the evening than in Brno.

The third most represented type consists of lines with a profile of so-called morning rhythm (C). These lines have only one maximum, which comes during the morning peak hours. They quickly rise to a high number of connections per hour (8–9% of all its daily connections), and then drop

Type ID	Line type	Brno					Bratislava				
		Lines		Connections		Lines		Connections			
		Line ID	Abs.	Rel. [%]	Abs.	Rel. [%]	Line ID	Abs.	Rel. [%]	Abs.	Rel. [%]
A	Peak	27, 30, 31, 32, 34, 36, 37, 40, 41, 43, 44, 46, 49, 50, 52, 53, 55, 57, 58, 60, 61, 63, 65, 67, 69, 70, 71	27	35.5	2,264	42.7	33, 64, 211, 21, 23, 28, 30, 31, 32, 37, 53, 56, 57, 63, 65, 66, 67, 68, 70, 77, 78, 83, 84, 88, 90, 93, 94, 95, 98, 525, 801	31	28.4	2,391	41.0
B	Homogeneous	2, 4, 5, 6, 11, 25, 38, 76, 78, FU	10	13.2	1,094	20.6	1, 2, 3, 4, 5, 6, 8, 9, 210, 39, 51, 54, 50, 69, 87, 91, 99, 123, 139	19	17.4	1,678	28.8
C	Morning	1, 3, 8, 9, 26, 35, 39	7	9.2	831	15.7	201, 202, 203, 204, 205, 207, 208, 209, 212, 61, 96	11	10.1	945	16.2
D	Industrial	10, 47, 54, 75, 77, MO	6	7.9	343	6.5	7, 52, 74, 75, 80, 191, 196	7	6.4	374	6.4
E	Afternoon	12, 33, 42, 64, AV	5	6.6	480	9.1					
	Unclassified	48, OL	2	2.6	90	1.7	24, 43, 44, 92	4	3.7	101	1.7
	Low-frequency (< 20 connections)	E50, 68, 73, 74, E75, 80, 81, 82, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99	19	25.0	196	3.7	25, 26, 27, 29, 35, 41, 58, 59, 79, 130, 133, 147, 151, 153, 184, 192, 901, N21, N29, N31, N33, N34, N37, N44, N47, N53, N55, N56, N61, N70, N72, N74, N80, N91, N93, N95, N99	36	33.0	322	5.5
In total			76	100	5,298	100		109	100	5,829	100

Tab. 3: Types of public transport lines with different rhythmicity of connections during a workday
Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

to 6–7% of all its daily connections per hour, and remain at this level until 19:00, when they slowly descend to their night minimum. Despite the fact that these lines in Bratislava retain a higher frequency until later hours, this line type has a similar importance for both cities, representing 10% of all lines and 16% of all connections.

The fourth type, which is the last classified type that the two cities have in common, consists of lines that are linked to industrial production (D). The industrial type differs greatly between the two cities, which limits its use for comparability. Nevertheless, it represents lines with two pronounced peaks, which differ from the peak type by the fact that the number of connections during the gap drops to almost zero values. In other words, these are lines with (almost) suspended operation. The main difference lies in the fact that while in Bratislava, this type has only two peaks (in the morning and in the afternoon), in Brno a third peak can be found in the evening hours. They are of similar scope in both cities, representing about 7% of lines and 6.5% of all connections. Their temporality is different, however, in that the two-phase cycle in Bratislava refers to a one-shift or two-shift work organisation, while the three-phase cycle in Brno indicates work organisation into more shifts (see Fig. 7).

The one type which could be identified in only one city, was the afternoon type (E) found in Brno. Its rhythmic profile is to a large extent inverse to the morning type, having only one maximum during the daylight hours – in

the afternoon, typically between 15:00 and 18:00. Such a rhythmic profile was not found with any public transport line in Bratislava. In contrast, Brno had 5 lines with 480 connections (9.1% of all connections) operating in this rhythm. The relative share of connections rises only slowly during the morning hours to reach the average value of 5.5% of all its daily connections per hour, which happens around 7:00 and is kept at this value until 13:00, when it starts ascending to its maximum of 8% connections per hour, from which it gradually falls to its minimum reached around midnight (see Fig. 8).

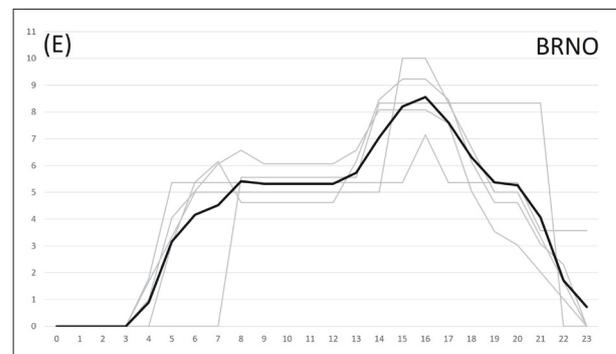


Fig. 8: The distributions of the relative number of connections of the afternoon line type of public transport on a workday in Brno. Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

If we compare the absolute numbers of connections operating for all lines of the designated types in the two cities, we can identify slight rhythmic differences. The biggest disparity is found in the different significance of the homogenous line type, which has a much stronger status in Bratislava than in Brno. To a certain extent, Brno compensates for this difference by the afternoon type of lines. In general, it can also be said that evening transport is organised differently. While in Bratislava all lines are extended until late evening hours and provide for evening transport in a balanced way, Brno counterbalances the evening deficit by a specific industrial line type with a third peak – but this type is limited to a low number of lines (see Fig. 9). The cities also exhibit different rhythmicity in terms of the respective modes of transport: while trams in Bratislava almost solely (with only one exception) belong to the homogeneous type, in Brno they fall under two line types: the homogeneous and the morning type. Thus, it can be said that trams do not contribute to the increase in connections during the afternoon peak in either of the cities, but in Brno they partially feed the morning peak.

Looking at the distribution of line types from a spatial perspective, a comparison of the two cities highlights their different topographies. While Brno is a relatively compact and concentric city, Bratislava is more influenced by its terrain and spreads in several convenient directions further from the centre. This is reflected in their urban times. While Bratislava uses the peak line type to connect more distant suburban areas, Brno concentrates it in the residential areas in the north-west. The homogeneous line type in Brno mostly operates in the central parts of the city, while in Bratislava it is relatively evenly represented in the whole urban area. Similarly, the industrial line type in Brno is mainly limited to the south-eastern part of the city (the largest industrial zone), but in Bratislava, it operates more proportionally around the whole city. On the contrary, the morning lines in Bratislava are concentrated in the central areas, but in Brno they mainly service the housing estates. From the above-mentioned comparisons, it can be concluded that urban time in Brno is more local-specific, while in Bratislava it merges into a heterogeneous urban time with various partial temporal components of the whole city (see Figs. 10 and 11).

5. Conclusions

This research project set three goals: empirical, methodological and theoretical. At the empirical level, it can be concluded that both cities and their urban times are very similar, which stems from their analogous population size, similar sociocultural context and a long period of existence within a common state. In the basic comparison, the public transport in Bratislava shows somewhat higher numbers than the public transport in Brno, and it can be said that it has a larger scope. The essential rhythm of the workday is almost identical in both cities with two peaks and one gap in between. The active part in Bratislava is nevertheless longer, thanks to the evening hours, when Bratislava “goes to sleep” more slowly. On a weekend day, Bratislava starts earlier and finishes later than Brno. While Bratislava clearly outnumbers Brno in the absolute number of connections, when comparing the relative average number of connections per line, Brno shows higher values. In general, it can be said that Bratislava offers more lines, which have lower average frequency of connections both on workdays and during weekends, compared to Brno.

Based on a spectral analysis of all lines, four rhythmic types were identified in Bratislava (A–D) and 5 in Brno (adding E): peak (A), homogeneous (B), morning (C), industrial (D) and afternoon (E) types. The largest difference was found between the homogeneous, the industrial and the afternoon types. In Bratislava, the homogeneous lines are much more numerous, as far as their sheer number and their number of connections are concerned, and they are in service – even if with a lower frequency of connections per hour in general – until later evening hours. The industrial type of lines in Bratislava have only two peaks (in the morning and in the afternoon), while in Brno they have also a slight evening peak besides these two. The afternoon type of line was identified only in Brno. The urban time in Brno is thus more heterogeneous and local-specific, while in Bratislava, it is more temporally homogeneous in the sense that rhythmic profiles are mixed in the whole city area in a more even manner. Despite the strong similarities of both studied cities, the described differences of urban times reveal the potential for comparative chrono-urbanism, time planning and the time policies of urban spacetime.

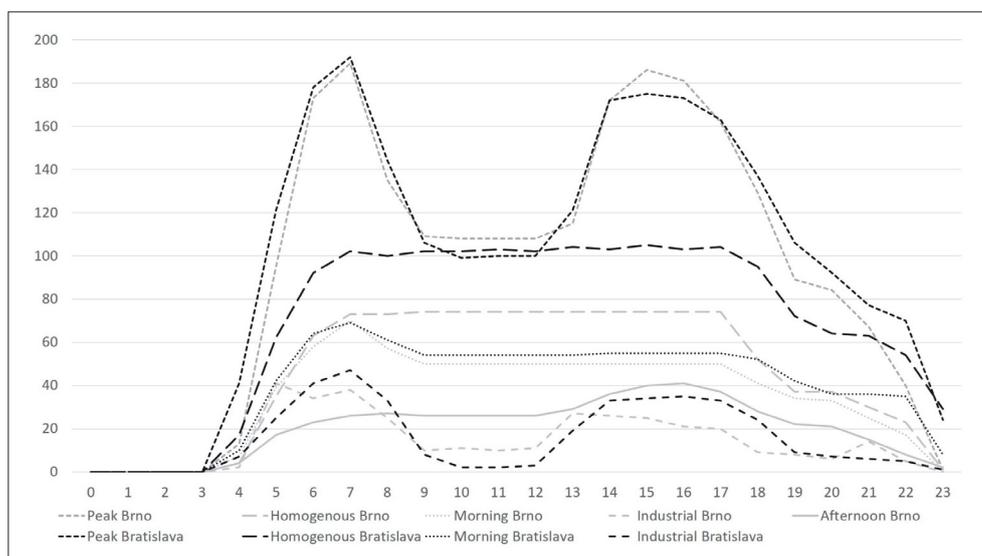


Fig. 9: The distribution of the absolute numbers of all types of public transport connections on a workday
Sources: Public transport timetables in Brno and Bratislava (both valid on 1st September 2016)

At the methodological level, we have presented a concrete procedure for making this comparison. Comparative chrono-urbanism, as we call it, can be divided into six steps. The first step consists of (i) selecting cities that are comparable, i.e. they have a similar character and the differences in their urban times will not be affected by some radical structural distinctions. The second step means to (ii) operationalise

urban time in all compared cities. This operationalisation must be carried out in relation to the available datasets that exist for all cities and that bear some temporal information. Besides datasets with timetables, urban time can be represented by opening times of shops, services and offices, ATM withdrawals or by the amounts of energy consumption in a network.

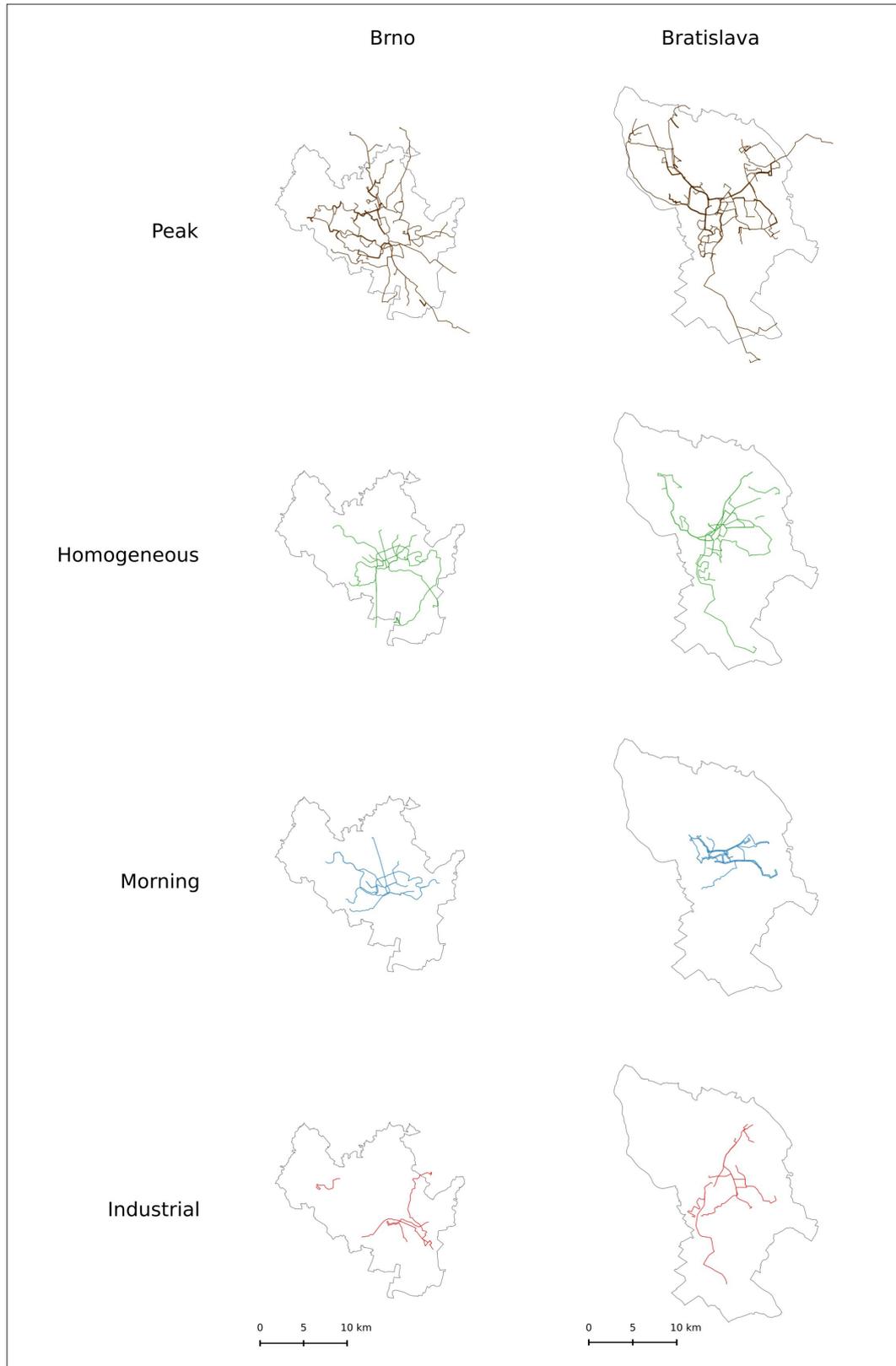


Fig. 10: Spatial analysis of public transport lines according to rhythmic profiles of connections
 Source: authors' analysis

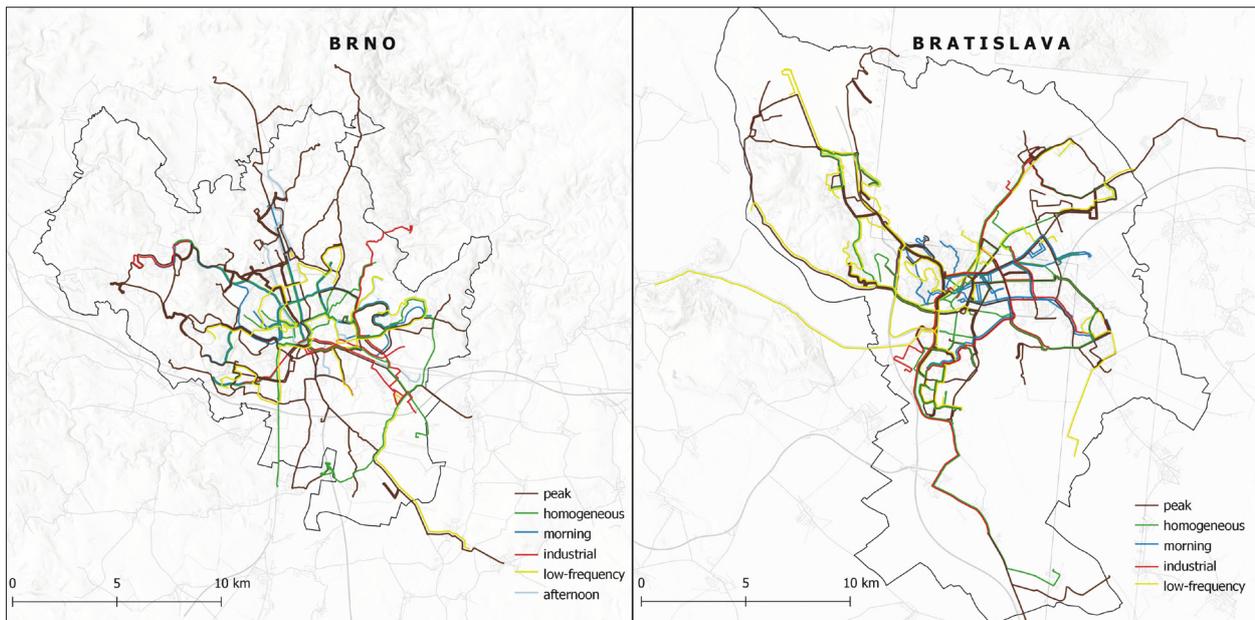


Fig. 11: Spatial synthesis of public transport lines according to rhythmic profiles of connections
Source: authors' analysis

The third step (iii) is to analyse the data as a whole, when urban times of the entire cities are compared (Figs. 1, 2, 3, 5). Then, as the fourth step, (iv) the institutional carriers of urban time (in this case, lines of public transport) are analysed. Their time characteristics are visualised in a graphical manner and overall urban time is divided into spectral profiles of a multitude of heterogeneous times. Due to a high number of carriers, the spectral profile of thus construed urban times is difficult to interpret (see Figure 6), and that is why it is necessary to carry out the fifth step and (v) cluster lines into so-called rhythmic types. In this step, rhythmic profiles of the respective institutional carriers of urban times are compared, and based on their similarity, their types are inductively derived (see Figs. 7 and 8). Lines are then divided into these line types and the urban times of cities are compared on the basis of these rhythmic types (see Fig. 9). The last step (vi) restores the spatial dimension of the rhythmic types, and urban times are analysed according to their spatial distribution in the city area (see Figs. 10 and 11). Comparative chrono-urbanism thus makes it possible to compare urban time at three levels: at the level of the whole city, at the level of individual types of urban times, and at the level of the spatial distribution of these urban times. Even in great detail, this process makes it possible to keep a high standardisation of urban time comparisons, which is necessary for applications to a greater number of urban times and which can increase the interest in time policies and urban planning.

At the theoretical level, this paper has explored the possibility of a comparison of time policies of two or more cities at one moment, or one city in two or more time periods. To this end, the article introduces a category of rhythmic types that brings together different carriers of urban time with the same rhythmic profile. The whole complex of urban time is simplified into a few rhythmic profiles and based on them the individual complexes of urban time can be compared with each other. We demonstrate this comparison on the rhythmicity of public transport. It is not a question of capturing one urban time in its complexity, but rather the selection of a suitable carriers of urban time that allows this comparability. Instead of public transport, for example,

the opening hours of retail stores, the development of water, gas or electricity consumption, the development of the intensity of financial transactions or the frequency of bank withdrawals, could be compared by analogy.

The theoretical value of comparative chrono-urbanism is not linked to any specific aspect of urban time and at the same time does not lie in capturing the whole complexity of the urban time of a certain city. Its main theoretical value lies in the possibility of comparing one urban time with another and making visible the differences between the urban times of individual cities. The identification and description of these differences is a valuable tool for urban time policies, both for the reflected and especially for the non-reflected. Awareness of the specificity of urban time can help urban planners face the issue of time policies and time planning, and to include the time aspect among the assessed consequences of specific urban decisions.

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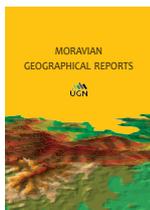
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A diversity of patterns: 10-year trajectories of men and women diagnosed with psychosis for the first time. A time-geographic approach

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Abstract

People with severe mental illness face a different ‘interventional’ landscape compared to some decades ago, when mental hospitals were dominant, in Sweden as well as in the rest of the Western world. The aim of the research reported in this article was to follow men and women diagnosed with psychosis for the first time over a 10-year period, and to explore what interventions they experienced. The interventions, here defined as “spheres”, were either community-based or institutional. A third sphere represents no interventions. Based on data from registers and using a time-geographic approach, the individuals were visualised as 10-year trajectories where their transitions between the different spheres were highlighted. The results show a great diversity of trajectories. Two main categories were detected: two-spheres (community-based and no interventions) and three-spheres (adding institutional interventions). One third of the population experienced only community-based interventions, with a higher proportion of men than women. Consequently, more women had institutional experience. Two sub-categories reveal trajectories not being in the interventional sphere in a stepwise manner before the 10th year, and long-term trajectories with interventions in the 10th year. The most common pattern was long-term trajectories, embracing about half of the population, while one-fifth left the institutional sphere before the 5th year.

Keywords: trajectories, psychosis, interventions/no interventions, time-geography, visualisation, gender, Sweden

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1. Introduction

When a person is faced with a diagnosis of severe mental illness (SMI), society will look upon, evaluate and treat the person, differently depending on when [in time] and where [geographically] this occurs. Until some decades ago, large-sized mental hospitals were the common form of treatment in the Western world, where people could spend years of their lives, secluded from the surrounding world. These hospitals have been called total institutions, referring not only to their size and foreclosure function,

but equally to the individuals’ collective submission to a totalitarian social system, regulating all aspects of their lives. The patients lived their lives in one limited institution, overlooked by an authority which replaced the different ways to live a “normal” life, outside the institutions: homes, workplaces, cinemas, stores, restaurants, forests, parks, etc. (Goffman, 1961). Hence, substantial control of the individual comprised all parts of everyday life with little or no regard to the individuality of the individual.

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For several decades now, de-institutionalisation has been the core-word for the development of new forms of interventions, basically meaning the closure of mental hospitals and the development of community-based interventions (Topor et al., 2015; Oots et al., 2013). This process aimed *inter alia* to normalise and improve the living conditions for persons with SMI (Marklund, 2005), to ensure citizen rights and enhance autonomy (Davidson et al., 2010). Even if this development can be problematised (for example, concerning economic improvement: see Topor et al., 2019), there has been a major change of living conditions for persons with SMI, in Sweden as in many parts in the Western world (Becker and Vázquez-Barquero, 2001; Priebe et al., 2005; Priebe et al., 2008). In Sweden, this change mainly took place during the 1980s and 1990s (Lindqvist et al., 2010; Topor, et al., 2015) and out-patient facilities, organised by the regional psychiatric care, and various types of social support, organised by the municipalities, were developed (Topor et al., 2015). Still, institutional interventions in terms of 24-hour care exist in terms of psychiatric inpatient care and supported housing, the latter organised by the social service sector.

The development towards community-based support has led to the involvement of different organisations providing interventions (Topor et al., 2011). As a result, persons with SMI are now facing an interventional landscape considerably different from the era of the mental hospitals. Although this development has been ongoing for several decades, little is known concerning what interventions persons with SMI are actually subject to. Interestingly, there is little knowledge about whether there are periods of no interventions over time as well. This gap of knowledge is somewhat striking, since the ultimate aim of interventions is to help the persons obtain a self-managed life.

As stated earlier, the interventions directed towards persons with SMI, were enacted at an institution of “brick and mortar” at one place, which also enclosed just about every aspect of a person’s life. Mental health geographers have stressed the importance of connecting SMI and societal changes and integration to place (De Verteuil et al., 2007) and activity space (Townley et al., 2009). This development has further been described in terms of a “post-asylum landscape” (Larsen and Topor, 2017), a “new institutional landscape” (Topor et al., 2015) or “landscapes of de-institutionalisation” (Wolch and Philo, 2000), all referring to physical terrain. In the wake of this development, the concept of a “fragmented interventional landscape” is used in this article (Andersson et al., 2019). The fragmentation refers to the appearance over time of the different organisations now operating in the field, representing different types of interventions enacted in different places and “spheres”.

The concept of “spheres” used in this study corresponds to what kinds of interventions persons diagnosed with psychosis are subject to. They might be embedded in an institutional sphere, including inpatient care or supported housing; or their lives might take place in a community-based sphere, where they live in a regular setting with community-based support of different kinds from different actors. A third sphere, vital in this study, is the non-interventional sphere which corresponds to shorter or longer periods with no interventions in a person’s life.¹

The transitions of each unique person between these three spheres can be seen as their trajectories over the 10-year period under study. By using different colours to represent each sphere, these trajectories are visualised, making it possible to follow the timing (when and for how long) and sequence in which persons with SMI move between spheres.

The use of the concept “trajectory” or “course”, is quite common in follow-up studies of persons with SMI, although the ‘object’ of what is being followed and “trajectorised” in such studies is rather diverse, as well as the duration of the follow-up periods. In general, follow-up studies of persons with SMI are afflicted with short follow-up periods (Pelayo-Terán et al., 2014), as well as missing data (Hegelstad et al., 2012; SBU, 2012) – and not including the diversity of interventions appearing (Topor et al., 2015). Another problem is that follow-up studies just pin-point specific moments and thereby miss continuity over time (see for example, Harrison et al., 2001; Wiersma et al., 1998). The focus in follow-up studies using the term trajectory or course, vary: such studies have a clinical focus, such as cognitive or social functioning (Barder et al., 2014, 2015; Gonzales-Blanche et al., 2015; Hall et al., 2015; Milev et al., 2005; Sanchez-Torrez et al., 2017), while others focus on symptoms (Abdin et al., 2017; DeVyllder et al., 2014; Pelayo-Terán et al., 2014) and treatment response (Levin et al., 2010). There are also studies with a more global outcome perspective, including living conditions (Ciompi, 1980; Green et al., 2013; Harrison et al., 2001; Wiersma et al., 1998). Long-term follow-ups exposing continuous trajectories on an aggregated level, revealing both patterns of and no interventions and including the diversity of interventions from different organisations do not, to our knowledge, exist.

One important result from studies with long follow-up periods is stated by Ciompi (1980, p. 420):

“...there is no such thing as a specific course of schizophrenia. (...) In the light of long-term investigations, what is called ‘the course of schizophrenia’ more closely resembles a life process open to a great variety of influences of all kinds than an illness with a given score.”

Twenty years later Harrison et al. (2001, p. 516) concludes in a 15-year follow-up that:

“Striking heterogeneity in the long-term course of schizophrenia challenges conventional notions of chronicity and therapeutic pessimism.”

The course of psychosis has also been investigated through biographical trajectories, relating to how the experience of psychosis constituted the notion of the self, culminating in five different types of trajectories with a variety from being ‘subsumed by’ to ‘assume agency’ over the experiences, the latter relating to examples of recovery (Georgaca and Zissi, 2019).

Lastly, few follow-up studies have been conducted in Sweden (SBU, 2012), and the ones that are have mostly a clinical focus, with some exceptions (Arvidsson, 2008; Bülow, 2004; Kjellman, 2003).

Hence, there is a need for studies including the different types of interventions provided in the fragmented interventional landscape that has developed after de-

¹ The definition of the different spheres occurring in the trajectories originates from a study in which everyday life was analysed on a daily level related to time and space (see Andersson, 2009). In this study the unit of analysis is ten years, but the spheres are still applicable.

institutionalisation. It is important to minimise drop outs (which is possible by the Swedish personal registration number) and to follow the indivisible continuous courses of indivisible individuals in a longtime perspective. Since the significance of a gender perspective in mental health studies has been stressed (Schön, 2010), we have acknowledged that as well.

In a previous article we focused on the trajectories of interventions (Andersson et al., 2019), investigating which type of intervention occurred in a trajectory, when and for how long. We found, for example, that while it was more common among women to be subject to institutional interventions, men spent more time in the institutional sphere since the sequences of institutional care in the trajectories of men were longer. Further, we found that community-based interventions played an important role for both men and women, related to the recurring appearances in the trajectories. While the frequency of community-based interventions showed a slight decline after a few years among women, it increased among men. Another important and interesting result from the former study is that up to 70% of the total accumulated time over the 10 years for the total population, is time without interventions (*ibid.*). This will be further explored in this article.

The aim of this article is to explore the course of interventions and no interventions in the continuous trajectories over 10 years of men and women, after being diagnosed with psychosis for the first time. Thereby we could identify in what spheres persons with severe mental issues live their lives over the period. The research questions, related to gender, focus on: What patterns can be identified and how can they be categorised? Since the previous study (Andersson et al., 2019) focused on patterns of interventions, this study takes a major point of departure in the sphere of no interventions.

This is the third article using a time-geographic visualisation method, created especially for the Stockholm 10-year follow-up study of persons diagnosed with psychosis for the first time (see Andersson et al., 2019; Vrotsou et al., 2017). This new interactive method visualises individual trajectories of interventions, based on individual data, at an aggregate level. The visualisation method is inspired by time-geography (Ellegård, 2019; Hägerstrand, 1970). The previous published studies using this method of visualisation had different foci compared to the present study with its orientation towards patterns. The aim in Vrotsou, et al. (2017) was to thoroughly present and explain the method (data conventions, functionality, visual representation) and how it could be used on the dataset

Ages	Men	Women	All
18–24	26 (13%)	18 (10%)	44
25–34	54 (26%)	45 (27%)	99
35–44	72 (35%)	43 (24%)	115
45–54	36 (17%)	31 (18%)	67
55–64	11 (5%)	25 (14%)	36
65–74	8 (4%)	4 (2%)	12
75–84	1	9 (5%)	10
85+	0	1	1
Z	208 (100%)	176 (100%)	384

Tab. 1: Age distribution at the time of diagnosis, 384 men and women. Source: authors' research

by showing some preliminary results. In Andersson et al. (2019), the appearances and frequencies of different types of interventions were exposed. The visualisation concentrated on one intervention at a time, not revealing patterns of fully exposed trajectories. The periods of no interventions were not explored as well. In the present article we take a step further and follow the courses, including the spheres of no intervention. This specific study is a part of a larger research project: "Persons with severe mental illness – living conditions, interventions and paths. A ten-year follow-up." The research team has an interdisciplinary background in social work, psychology, nursing, human geography and visualisation science.

2. Data

2.1 The study population

The study population consists of all persons who were diagnosed with psychosis for the first time between the years of 2000 and 2004, in all 447 individuals, in the catchment area of a mental health organisation in the southern part of Stockholm (with a total count of 282,000 inhabitants, of which 232,000 were 18 years of age and older). The catchment area includes inner-city parts as well as older and new suburban areas, with a diverse socio-economic population. The criteria for inclusion in the study were a psychosis diagnosis that complied with DSM-III-IV (Diagnostic and Statistical Manual of Mental Disorders) or ICD 10 (International Statistical Classification of Diseases and Related Health Problems). The included individuals should also have been in contact with the psychiatric care organisation during the year 2004. The study, then, is a longitudinal and naturalistic cohort study. All patients with psychosis diagnoses, according to the inclusion criteria, were included and the data presented reflected a psychiatric organisation that offered psychiatric care according to treatment as usual (TaU).

The follow-up period was ten years for every individual from the date of the diagnosis. This means that year "0" can differ, from year 2000 to year 2004. Out of a total population of 447, ten were missing in the registers, resulting in a total population of 437 persons. The 53 persons who died during the period (22 women and 31 men) are not included in this study, leaving a total of 384 individuals. There is a higher share of elderly women compared to men: 21% of the women and 9% of the men were over 55 years of age at the time of the diagnosis, turning 65 and more during the study period. This could have had an impact on what types of interventions the person is subject to (see Limitations).

2.2 Data and databases

Data for this study were collected from several registers. In Sweden, each citizen has a personal 'registration number' which facilitates the possibility to conduct follow-up studies with a minimum of dropouts. These numbers, connected to the persons in the study, appear in all registers used. After the approval of a Board of Ethics, data from different registers can then be linked together. This study was approved by The Regional Ethical Review Board (EPN) in Stockholm in 2005 (2005/ 2:1), in 2009 (2009/806-32) and in 2015 (2015/115532).

Data collected from which registers are presented in Table 2. For a more detailed description, see Topor et al. (2011).

By combining the different registers it is possible to reveal what spheres the individuals go between and, thereby, what different types of interventions they meet, how often these

Databases	Data collected
National Board of Health and Welfare-Hospital Register	Psychiatric inpatient care and diagnosis
Stockholm County Council – Psychiatric activity database (PVS)	Psychiatric out-patient care
Swedish National Council for Crime Prevention	Type of sanction*
Stockholm Municipality – Social Services database	Financial assistance, social support in daily living, occupational and rehabilitation interventions
Cause of Death Register	Death and cause of death

Tab. 2: Databases used and data collected. Source: authors' research

Note: * Nobody in the study-population was sent to jail during the follow-up period but seven men (five under 30 years old) were sentenced to forensic psychiatry)

interventions occur, for how long they last and from what organisation they originate. It is also possible to detect when the persons are subject to interventions and when they are not, at individual as well as group levels.

The data refer either to interventions from the regional psychiatry care or the municipalities' social services. Psychiatric care is divided between community-based interventions like medication and therapeutic support, and inpatient interventions. Social services embrace community-based social support specialised for persons with SMI-like support in daily living, occupational/activity support and supported housing with access to staff.

The intervention events collected from the registries are of varying temporal granularity, ranging from minutes (telephone call) to months or years (institutionalisation). In the data used in the study, the smallest time unit describing events has been set to a day. This implies that interventions with a duration less than a day (such as 'phone calls or visits) are considered instantaneous events and characterised by a daily time stamp, while longer interventions are considered as event intervals and characterised by a starting and end day.

3. Method and theoretical approach

The theoretical and methodological framework of this study is based on time-geography. As the concept of time-geography indicates, both time and space are important dimensions in a time-geographic approach, with the possibility to utilise different geographical and time scales (Ellegård, 1983; Hägerstrand, 1970, 1972, 1973, 1974; Lenntorp, 1976). A fundamental aspect of time-geography is the indivisible individual, reflecting the fact that the individual lives continuously during her lifetime, hence, the individual is indivisible. Indivisibility indicates that it is not possible for an individual to exist at several places at the same time. Consequently, all actions taking place in a person's life are sequentially tied to that individual in time and space. Furthermore, time-geography provides a notation system enabling the representation of an individual's continuous movement in time and space, which can be geographic or abstract space. In this study, the trajectories of individual men and women are visualised across the abstract space made up from the spheres of interventions, and taken together, they constitute an aggregated view of the population under study. In this way, continuous sequences of interventions, not seldom interrupted by periods of no interventions, are visualised, in analogy with the idea of the indivisible individual. Time-geography provides both concepts and methods for visualising individuals over time by continuous trajectories, which are suitable for longitudinal studies.

The spheres, which correspond to the individual's relations to different kinds of institutions providing interventions at different places, emanate from a qualitative everyday life study of persons with SMI (Andersson, 2009). Using time geographic diaries, Andersson constructed trajectories of the individuals' everyday life, hour by hour. A trajectory formed from time geographic diaries can clarify the individual's geographical, temporal and social anchoring. Consequently, by following the trajectory of an individual, different contexts of everyday life are revealed (Ellegård, 2001, 2019). The contexts identified by Andersson (*ibid.*) related to psychiatric and social interventions, including people and places of significance in everyday life. She also identified periods in life without interventions, and its social, temporal and geographical connotations. These contexts formed different conditions and framed everyday life (Andersson, 2009). The contexts discovered – community-based interventions, institutional interventions and no interventions – were then transformed into "spheres", a concept which can comprise abstract places with their various societal organisations and connotations, as well as physical places. The spheres, then, demonstrate a way to relate individual experiences and societal structures for persons with severe psychiatric problems, and they represent abstract places defined by their functions and rules. The community-based sphere includes places like outpatient clinics and activity centres, but also a person's home can be a place for intervention. Besides interventions and a social world populated by professionals, this sphere is represented by ordinary living and a varying extent of informal relations. The institutional sphere includes places like psychiatric clinics and supported housing, and the daily social contacts can be limited to staff and other patients/co-habitants (but potentially also friends and family). The no interventional sphere includes the home and most of the routine places where people perform activities in daily life, and the social contacts can be varied. This sphere can be interpreted as "normalised" living, in which the individual manages with no interventions.

Individuals have limited possibilities of action, and to deal with this in time-geography, three basic constraints are identified (Lenntorp, 1976; Hägerstrand, 1985; Åquist, 1992): authority, coupling and capacity constraints. Capacity constraints embrace the individual's physical and mental capacity, material assets, knowledge, etc. and are expressed in the interactions between the individual and the social, material and physical environment. One capacity restriction of people in this study is their psychiatric problems. Authority constraints refer to laws, rules, policies, etc. They exist at an organisational level and orchestrate the individual's room for manoeuvre; hence, it is problematic for the individual to change or influence

them. In this study, extensive authority constraints can be imposed on persons in special institutional settings in the institutional sphere, and less, but still substantial authority constraints influence the individual when in the community-based sphere, where the private home can be the base for daily life. Coupling constraints relate to individuals' opportunities to interact, i.e. to be in the same place at the same time as another individual and are based on agreements, negotiations and obligations. Coupling constraints are specifically time-geographic constructs and they reveal that there are several restrictions in a person's life caused by location, timing of activities and projects and decisions taken by others. They shed light on interdependencies and the importance of everyday logistics. The different types of constraints are mutually inter-related, and they affect peoples' opportunities to interact and to live their lives (Ellegård, 1998; Westermarck, 2003). As indicated, the different spheres reflect different types of constraints, which will be further developed in the following discussion.

In this study, (as well as in Andersson et al., 2019, and Vrotsou et al., 2017) the geographical dimension is 'toned down', although it is reflected in the different spheres corresponding to locations in a "fragmented interventional landscape". A person in the non-interventional sphere lives (most likely)² in a regular setting in society. The community-based sphere indicates a regular living situation combined with social support or medication, while the institutional sphere indicates that a person either is in a clinical setting 24/7 or in supported housing with staff.

3.1 The principle of visualisation

Figure 1 shows the principle of the visualisation used in this study. It is based on the trajectories of five persons, from the first year of the diagnosis of psychosis to the 10th year. Each person's path of intervention is represented as a bar-formed trajectory corresponding to their sequence of interventions over the 10 years under study. Time is represented on the vertical y-axis, while the horizontal x-axis displays the individuals, ordered side by side. The position of each bar along the y-axis corresponds to the start time of the corresponding event and its length depends on the duration of the event. If the event is instantaneous a bar of fixed size is used. The width of the bars is proportional to the size of the screen and the number of individuals displayed simultaneously. Hence, the trajectory of an individual should be read from the bottom to the top of the figure. The colours correspond to the different spheres: community-based interventions are marked in blue, institutional interventions in red, and time-periods without interventions are in white. When a person deceases, their remaining trajectory is coloured black (not shown in Fig. 1).

Trajectory A, to the left in the figure, visualises a person who initially mostly experiences institutional interventions (red) for almost three years. Then, for a short period, community-based interventions (blue) are mixed with periods of no interventions (white). For the rest of the 10-year period, this pattern persists: community-based intervention superseded by periods of no interventions with recurring short periods of institutional care. Trajectory B visualises a person who is subject to community-based interventions (blue) on and off for about a year and thereafter there

are no interventions appearing for rest of the 10 years. Consequently, the white area after the last intervention is part of the continuous trajectory, when the person is in the non-interventional sphere for the rest of the 10-year period. Trajectory C visualises a person with the same initial pattern as B but with the last intervention around year six, meaning the trajectory continues into the interventional sphere a few years later than B. Thereafter, C appears in the non-interventional sphere, with no further interventions. Trajectory D has a similar pattern as A, staying in the interventional sphere off and on for the whole period, but without any institutional interventions. The last example, E, reveals a trajectory with quite intense interventions, both community-based and institutional, for a year, then no interventions at all for five years and then community-based interventions at three more times for the rest of the period, leaving considerable periods of no interventions in between interventions. The trajectories of persons A and D exemplify what we call "long-term trajectories" and those of persons B, C and E exemplify "stepwise trajectories".

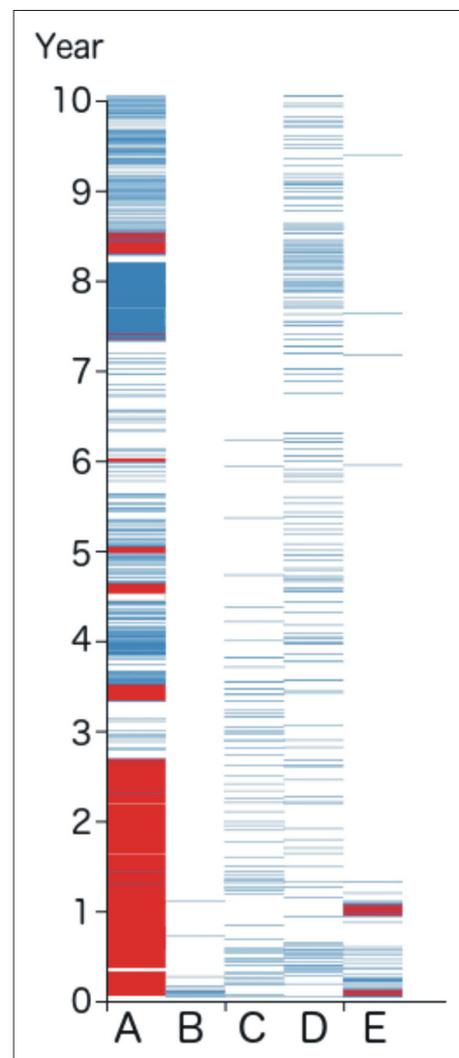


Fig. 1: Trajectories of five persons (A–E) with different experiences of the interventional spheres from 1st year of diagnosis to 10th year. The persons are arranged side by side on the x-axis, while the 10-year period constitutes the y-axis. Source: authors' elaboration

² Almost all the people in this study lived in ordinary housing at the time of the diagnoses. Data is missing concerning six persons. It is possible that some or all of them could be homeless.

The principle of the aggregated pattern of trajectories was shown in Figure 1. In the same manner, the aggregate trajectory patterns of the total population are captured in Figure 2.

Taken together, all the trajectories reveal the aggregate pattern over the ten-year period. All trajectories are exposed side by side, men to the left, women to the right, divided by the yellow line. Year “0” is at the bottom line. The figure shows a diversity of trajectories where the red parts of a trajectory corresponds to time sequences at institutions and blue, community-based

support. The white parts of a trajectory represent time without any interventions, and black the persons that died during the follow-up. In the present article, all these trajectories (minus the black) have been analysed and categorised.

It is crucial in this study that each individual is regarded as indivisible since the interventions that each individual is subject to and the sequences of no interventions oscillate between the different spheres over time, thereby, shaping the trajectory’s sequential pattern of different spheres for each individual.

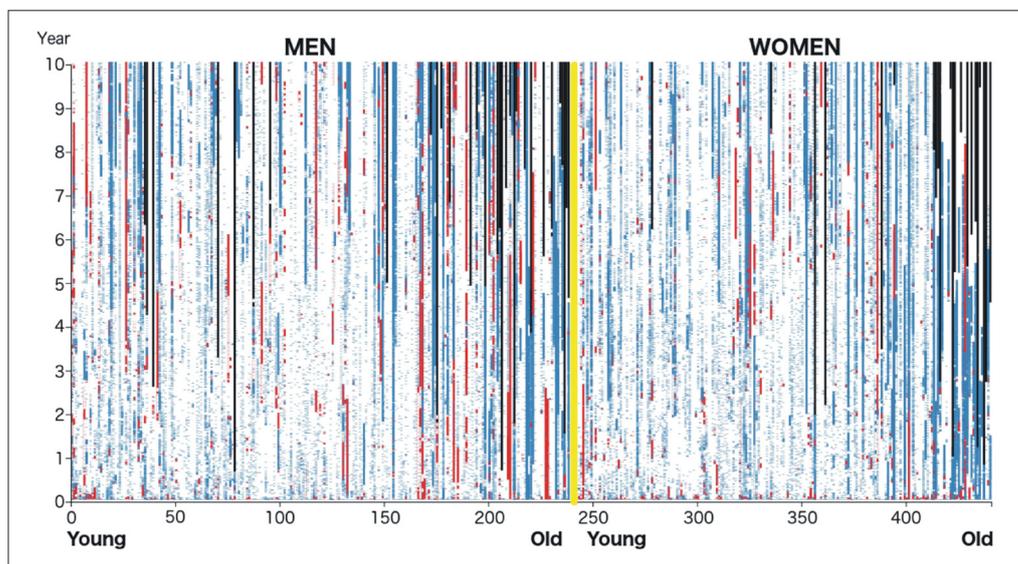


Fig. 2: All trajectories, including the dead (the trajectories are black after death), men to the left, women to the right
Source: authors' elaboration

The system used for visualising and analysing data from the registers is web-based. The system was specifically designed for this follow-up study (and for the study presented in Andersson et al., 2019) and is fully presented in Vrotsou et al. (2017). The inspiration for the visualisation originates from Ellegård and Vrotsou (2006) and Vrotsou (2010). The visualisation method follows the time-geography approach in having its point of departure in the indivisible individual (Ellegård, 2019; Hägerstrand, 1970).

3.2 Analyses

For this particular study, the trajectories were organised manually during the analysis. The first principle of the categorisation emanated from what spheres could be detected in the trajectories and according to what pattern. Investigating each and every trajectory we found that no one included just one sphere, instead there were either just community-based interventions along with periods of no interventions, or both community-based and institutional interventions along with periods of no interventions. Then all trajectories were defined after this principle, resulting in two main categories: two-sphere trajectories and three-sphere trajectories.

The next step was to identify patterns within these two main categories. Since the main point of departure was the pattern of no interventions, the trajectories were sorted with respect to the time of occurrence of the last intervention present in their trajectory. This revealed a step-like pattern starting with the shortest trajectory: i.e. having the last intervention ending earliest of all (just a few months after the time of the diagnoses) and gradually increasing until the longest trajectory is reached: i.e. including interventions

spanning until the end of the 10-year period. In sum the step-wise order shows when the trajectories “leave” the interventional sphere (blue or red) and continue in the non-interventional sphere (visualised by turning white) at different times up to the 10th year.

In the further analyses, two subcategories of interventions emerged: stepwise intervention trajectories, displaying individuals not being in the interventional spheres up to the 10th year, and long-term interventional trajectories, individuals still being in the interventional sphere the 10th and last year. In that way we could analyse the patterns of trajectories not being in spheres of interventions and those still with interventions during the last and 10th year, separately.

An important time unit in the analysis of the material is the full year. The choice of a year was two-fold. Being without interventions for a year shows a potential to manage without support for a substantial period of time. It also seemed to be the most effective way to visualise the discrepancy in patterns. A third sub-subcategory emerged from the long-term interventional trajectories: those with less than a year of coherent periods without interventions, revealing dense patterns of interventions and trajectories with a year or more with coherent non-interventional periods, which are defined as sparse patterns. This gave us a tool to further examine the long-term trajectories and, thereby, spot trajectories with the most long-lasting and intense patterns of intervention and the ones with less such features.

This article focuses on patterns of no-interventions in the trajectories. For a more thorough presentation of the interventional parts of the trajectories, see Andersson et al. (2019).

3.3 Limitations

This study is affected by limitations, mainly concerning registration and categorisation. But the age distribution should be mentioned as well. Among women, 39 are over 55 years of age at the time of the diagnosis, and 20 men. In a ten-year perspective they turn 65 and older, reaching retirement age during the follow-up period. This could have implications on the types of interventions since social services has special interventions after 65 years, such as homes for elderly persons. Our data, however, show that only four persons (three women, one man) were subject to this type of institutional care (and mostly for short periods), meaning that most of the institutional interventions are connected to the psychiatric problems and not primarily to age.

Community-based psychiatry care and community-based social services register interventions differently. Psychiatric care registers every actual meeting with the person, while the social services register is based on formal decisions valid over a time period (for example, six months of social support). As a consequence, interventions from social services will sometimes appear as longer coherent (blue) parts in a trajectory. How often the actual intervention appears during this period is not known, but other studies reveal that, for example, social support in daily living often occurs once or twice a week (Andersson, 2009; Andersson et al., 2015). A similar coherent (blue) pattern will appear when psychiatric care has a frequent contact with a person, at least once a week. Less frequent contacts will appear as dots in the aggregate visualisations. This is a limitation in cases when interventions from social services appear more seldom than once a week, and then a similar dot-like pattern would be more relevant.

Another limiting factor is the potential effect of our visualisation choices in relation to the temporal aspect of the data. The total time span of the data is 10 years and within this time the minimum time unit with which interventions are represented is a single day. Over the entire 10-year study period interventions from different spheres can occur in parallel: for example, several community-based interventions can occur during longer institutional interventions. The large variation of interventions in temporal granularity, as well as their temporal overlaps, have a considerable effect on the visualisation of the data. Longer events or several short ones occurring consecutively appear more prominent in the representation, since they are visible as continuous long bars in the trajectories. At the same time, temporally scattered short events create a cluttered impression and become harder to distinguish. Moreover, overlapping interventions are also represented, overlapping in the visualisation which increases the clutter. Choosing a coarser temporal resolution, for example a monthly resolution, and applying temporal aggregation to the data would considerably reduce this clutter in the representation. This, however, would require us to choose a single intervention to be the representative ongoing event of that period, which would imply considerable loss of information. In our work we have chosen not to aggregate the data in this manner, partly because we wanted to retain the visibility of the large temporal variation, but more importantly because we did not want to lose information concerning the shorter (community-based) interventions by using a more coarse temporal resolution.

Categorisation demands choosing break points and those choices will impact the results (see for example, Topor et al., 2018). The choice of at least one year without

interventions afflicts the creation of the two main categories and the distinction between dense and sparse patterns. A two-year limit, for example, would separate the trajectories differently but would not capture trajectories with tightly recurring interventions as well. Another way to categorise the trajectories could be to cluster the different spheres in order of appearance or amount of time spent in each sphere. The visualisation program in its current status, however, will not allow that, and to handle all spheres manually would be too complicated. This would be something to develop for future research.

It would have been an advantage to be able to make thorough and exact comparisons to the previous study focusing on the periods of interventions rather than periods without interventions (Andersson et al., 2019). This is due to the choice of not including the dead in this study, since there would be too many categories to overview. Although the 53 deceased persons are excluded here, the overall results from the two studies correspond and can therefore serve as references when needed.

Lastly, there might be persons diagnosed with psychosis between 2000 and 2003 that were not in contact with psychiatry in 2004, the year of inclusion. This means there might be more persons that we define as “early leavers” (not subject to any interventions after the 5th year) in the catchment area, but not included in the study.

4. Results

The aim of this study was to explore the patterns of two kinds of interventions and no interventions in the trajectories of men and women after being diagnosed with psychosis for the first time, and to present the results according to sex. From the population of 384 persons, the results reveal trajectory patterns forming two main categories:

- Trajectories transitioning between two-spheres – community-based interventions (blue) and no interventions (white); and
- Trajectories transitioning between three-spheres – community interventions (blue), institutional interventions (red) and no intervention (white).

Within each category, two subcategories were defined depending on the distribution of interventions over the course of the 10-year study period, as was described above. First, trajectories including persons entering the non-interventional sphere in a step-wise order from the 1st up to the 9th year, which we define as “step-wise trajectories”. Second, trajectories illustrating persons who are still involved in the interventional spheres during the 10th and last year, which we define as “long-term trajectories”. The results will be presented according to the scheme in Figure 3.

4.1 Two-sphere trajectories

The 112 men and women in the first main category composed of trajectories involving two spheres, have only experienced interventions from the community-based sphere combined with no interventions, for example social support in daily living, occupational/activity support, medication, therapeutic support, etc. Comparing the amount of men and women in this category, there are 62% men and 38% women.

Figure 4 displays all trajectories representing the two spheres in this category: community-based interventions (blue) and no interventions (white). Women are shown to

the left and men to the right sorted in a step-wise pattern according to the time for their last occurring intervention (as described in Section 3.2: Analyses). In the following, in order to study the trajectories closer, the figure will be split up into two parts according to the subcategories defined: the stepwise trajectories (interventions within the first 9 years) and the long-term trajectories (interventions during the whole 10-year period).

4.1.1 Stepwise trajectories

Figure 5 illustrates trajectories transforming into the non-interventional sphere for the rest of the period in a stepwise order from the 1st to the 9th year (leaving at least a year at the end with no intervention). Out of the 43 women with only community-based interventions, 24 are found in this category. It is noticeable that more than half of these women (15) are not subject to any interventions after the 5th year. We will refer to them as “early leavers”, meaning that they leave the interventional sphere for the rest of the period.

Compared to women, there are relatively fewer “early leaving” men. Looking at the figure, there is a rising curve formed by the last interventions revealing around a third (12) without interventions after the 5th year. Although the

lowest common denominator in the stepwise category is that interventions cease to appear before the 10th year, they show various patterns up to that time. Some of the trajectories among both men and women have substantial periods of no interventions between interventions. Others show a pattern of densely recurring interventions.

4.1.2 Long-term interventional trajectories

The subcategory long-term interventional trajectories includes trajectories of persons still appearing in the interventional sphere during the 10th and last year. The patterns are quite diversified up to that point. Some have a pattern of dense recurring interventions during the whole period, and some have substantial periods of no interventions, just like the trajectories in the stepwise formation.

There are 19 women and 38 men with long-term trajectories. The trajectories with dense patterns are presented to the left in the sub-figures of Figure 6, and the ones with a more sparse pattern of interventions to the right, thereby spotting trajectories with the most long lasting and intense patterns of intervention and the ones with longer periods of no intervention. Among the women there are about as many trajectories with recurring dense

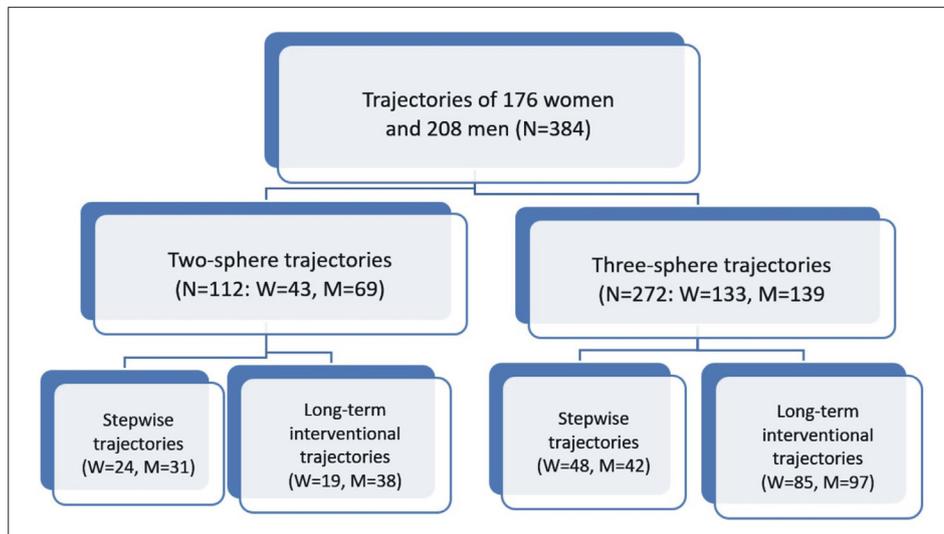


Fig. 3: Scheme of presentation of the results
Source: authors' elaboration

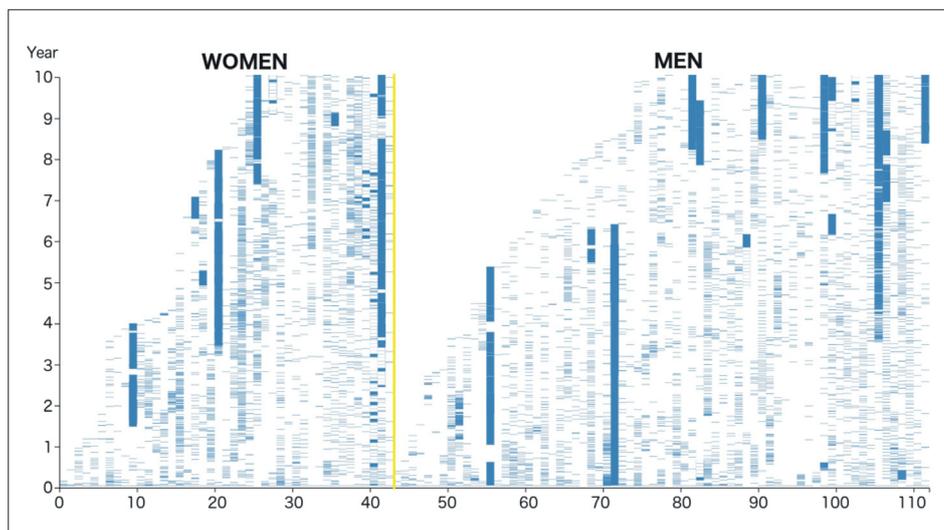


Fig. 4: Two-spheres trajectories: women to the left (n = 43), men to the right (n = 69)
Source: authors' elaboration

patterns of intervention as there are with extensive gaps without interventions. Among the men it is more common with a sparse pattern than dense. There are as long coherent periods without interventions of three to five years among women and three to eight years among men.

4.2 Three-sphere trajectories

The three-sphere main category reveals, not surprisingly, even more complex patterns, since institutional interventions (in-patient care or supported housing) are added to the community-based interventions and non-interventions. This category consists of 272 trajectories, about as many women, 133, as men 139 (Fig. 7).

This section will be organised in the same way as the two-sphere part, starting with trajectories in stepwise order followed by long-term trajectories.

4.2.1 Stepwise trajectories

Figure 8 exposes the stepwise trajectories of 48 women and 42 men, which is about a third of men and women respectively with institutional experience. More men (about half) than women (about a third) are “early leavers” in this category, noticed in a curve among men that is more levelled out. Compared to early leavers in the two-sphere category, the amount of men and women are reversed. In this category as well, the trajectories show various patterns up to the last

intervention. Some show extensive periods of no interventions and some extensive periods of interventions. Comparing the different types of interventions (community-based and institutional), most of the institutional interventions occur as short periods in time, but, longer periods of institutional care also exist³.

4.2.2 Long-term trajectories

The next subcategory with three-spheres trajectories exposes long-term trajectories where the last intervention occurs during the 10th and last year. As noted previously, there can be a substantial disparity in patterns.

There are 85 women and 97 men with long-term trajectories, including institutional experiences. The trajectories with dense recurring interventions are placed to the left and those with longer coherent periods of no intervention are presented to the right in Figure 9.

There are 50 women with dense patterns in their trajectories and 35 with sparse patterns. Most of the women with sparse patterns in their trajectories have around a year at a time without interventions, but some have coherent periods between two and as long as seven years. Among the men as well, dense patterns are more common than sparse (60 versus 37). Half of the trajectories with sparse patterns show periods of around a year and the rest between two and five coherent years without any interventions.

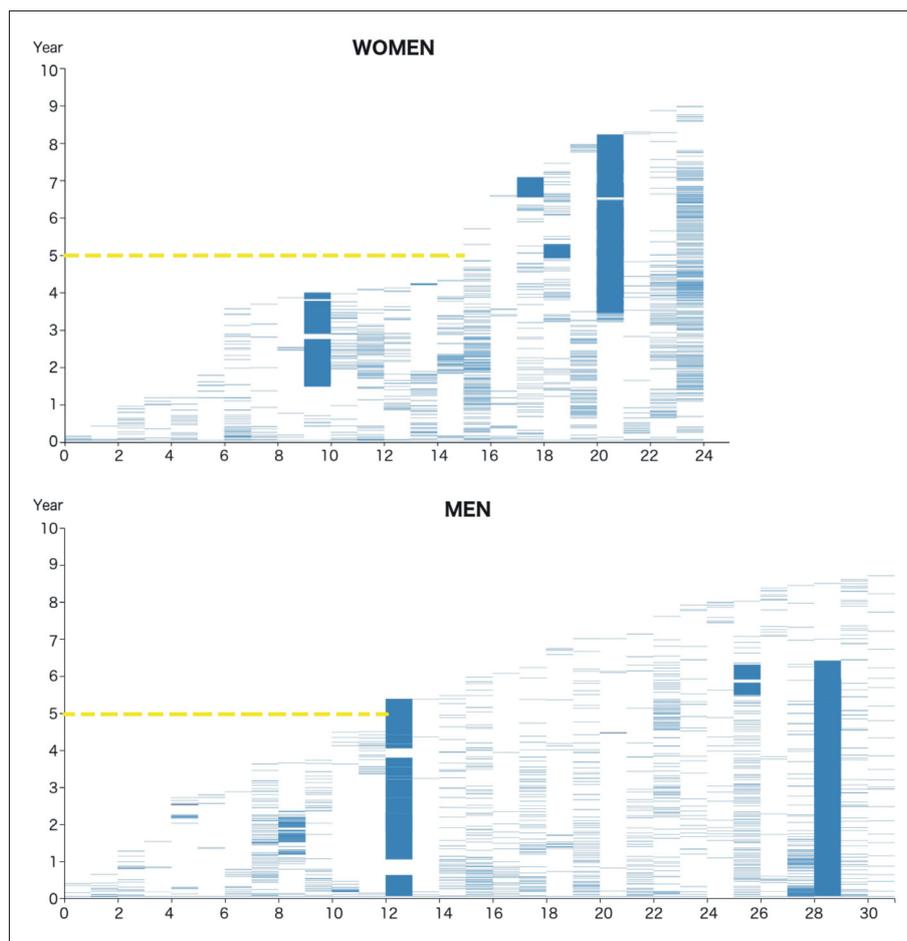


Fig. 5: Two-spheres stepwise trajectories: women at the top ($n = 24$), men below ($n = 31$)

Source: authors' elaboration

³ According to Andersson et al. (2019) the extensive periods of institutional interventions often correspond to housing rather than clinical care. The population in this article is not exactly the same as in Andersson et al. 2019, not including the dead, but the overall results from the two articles correspond

4.3 Summary

In Table 3, the main results are compiled in percentage terms, according to sex. The distribution of stepwise and long-term patterns shows that long-term trajectories are more common for both women (60%) and men (65%). There is also a difference between the spheres in long-term trajectories: 11% of the women have only community-based interventions versus 48% with institutional experience as well. Among

men the discrepancy is 18% versus 47%. Dense patterns in long-term trajectories with institutional interventions are more common than sparse, among both women and men. In the stepwise category we can notice that 18% of the women and 16% of the men can be referred to as "early leavers", not having any intervention for at least five years. While there is hardly any difference between the spheres among the women (8% and 10%), there are more men with institutional experience in this category (11% versus 6%).

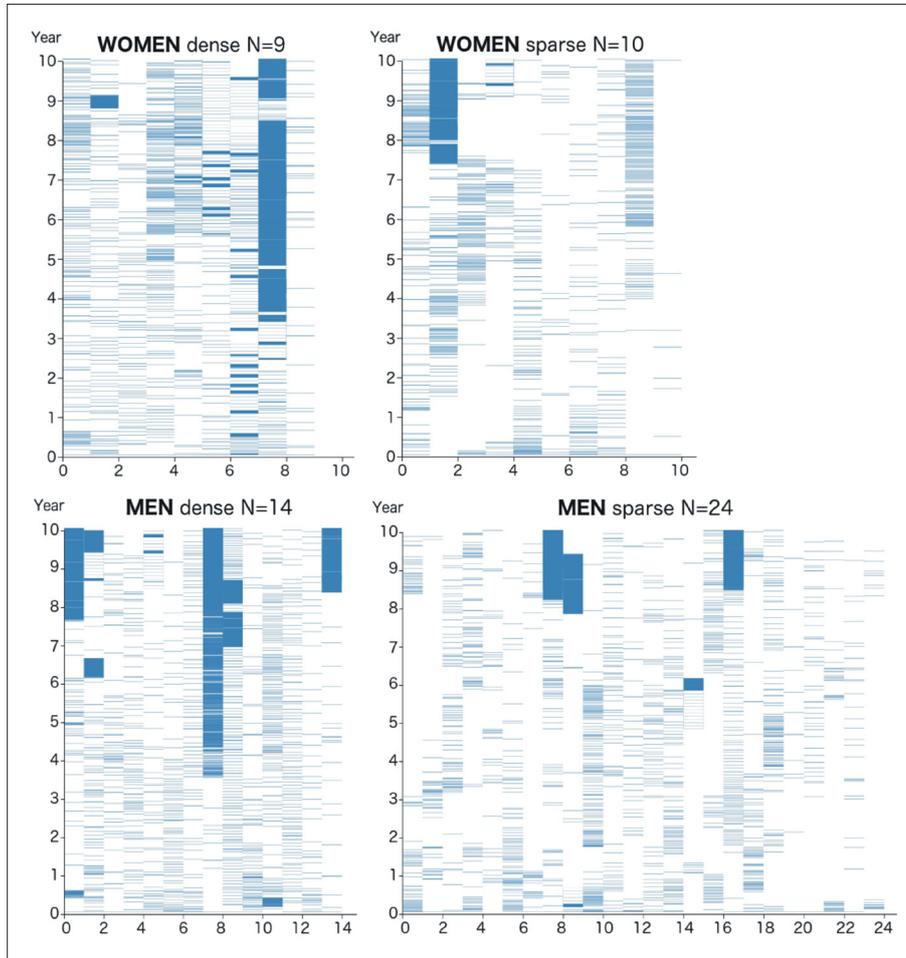


Fig. 6: Two-spheres long-term interventional trajectories: women at the top (n = 19), men below (n = 38)
Source: authors' elaboration

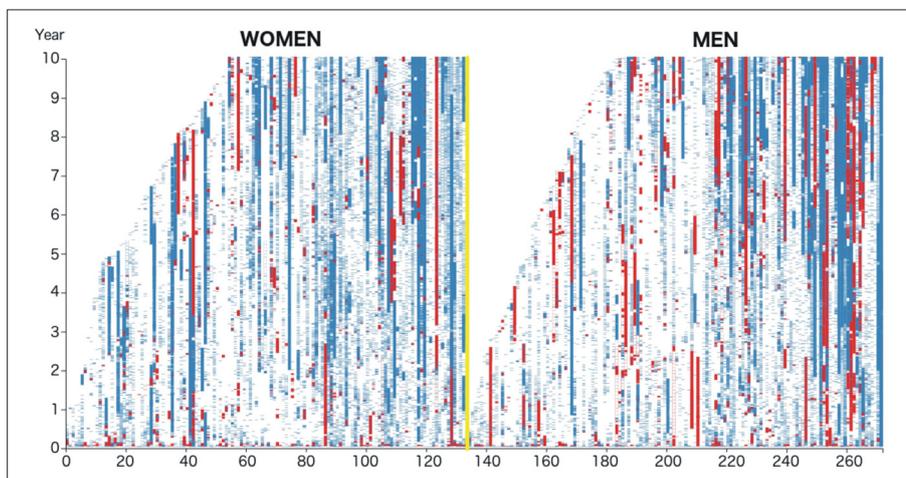


Fig. 7: Three-spheres trajectories: women to the left (n = 133), men to the right (n = 139)
Source: authors' elaboration

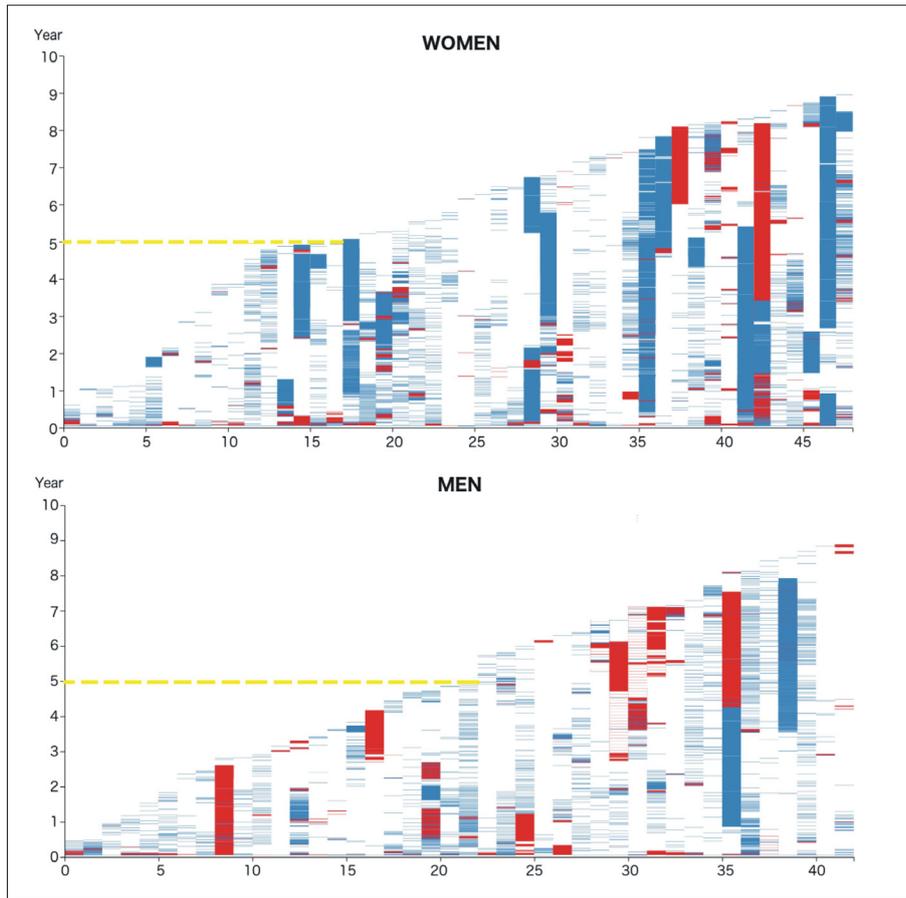


Fig. 8: Three-spheres stepwise trajectories: women above ($n = 48$), men below ($n = 42$). Source: authors' elaboration

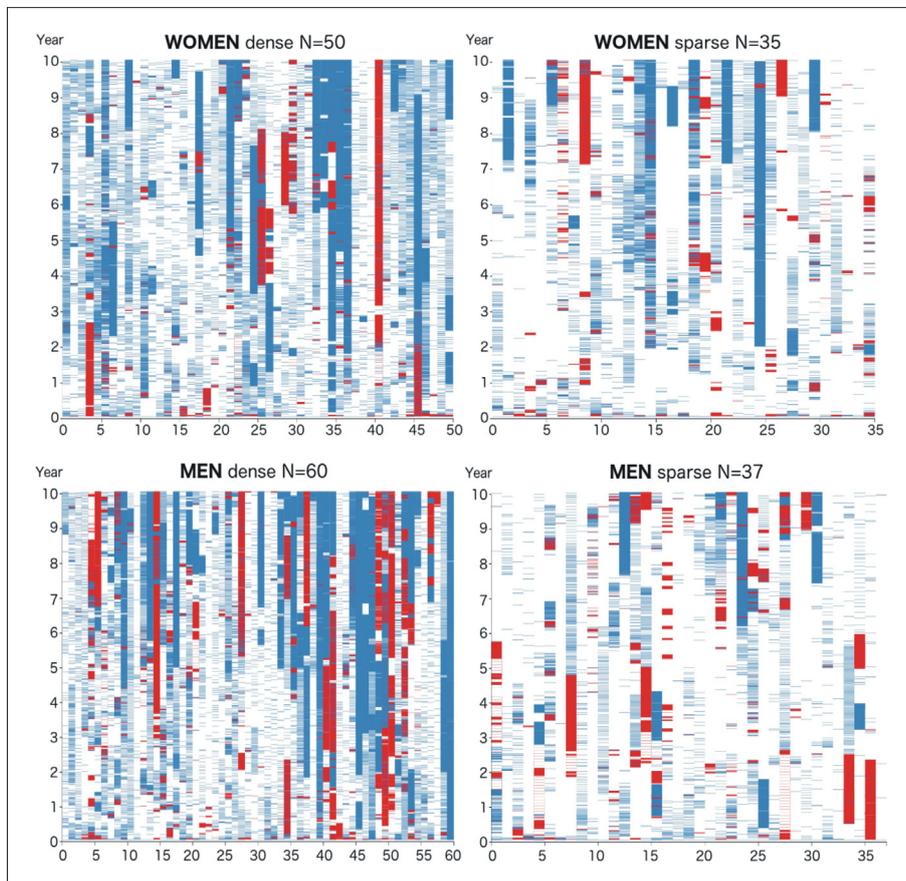


Fig. 9: Three-spheres long-term interventional trajectories: women at the top ($n = 85$), men below ($n = 97$). Dense trajectories to the left, sparse trajectories to the right. Source: authors' elaboration

Women (N = 176)	Total % (number)	Two-spheres N = 25% (43)	Three-spheres N = 75% (133)
Stepwise	40% (72)	14% (24)	27% (48)
	E: 18% (32)	E: 8% (15)	E:10% (17)
Long-term	60% (104)	11% (19)	48% (85)
	S:26% (45)	S:6% (10)	S:20% (35)
	D: 33% (59)	D:5% (9)	D:28% (50)
Men (N = 208)	Total % (number)	Two-spheres N = 33% (69)	Three-spheres N = 67% 139
Stepwise	35% (73)	15% (31)	20% (42)
	E: 16% (34)	E:6% (12)	E: 11% (22)
Long-term	65% (135)	18% (38)	47% (97)
	S: 29% (61)	S:11% (24)	S: 18% (37)
	D: 36% (74)	D: 7% (14)	D: 29% (60)

Tab. 3: Main and sub-categories, according to sex (*E* = Early leavers, *S* = Sparse, *D* = Dense)
Source: authors' elaboration

5. Discussion

This article contributes new knowledge about men and women diagnosed with psychosis as subjects to interventions offered by society from the year of diagnosis and ten years later. People with severe mental illness faced a different landscape of interventions after the era of the large institutions, and still the knowledge of what types of interventions, when they occur and for how long, has been insufficient. In this article we explored when they experienced what interventions and identified periods without interventions. We used a time-geographic approach and studied the consequent trajectories of these women and men.

5.1 Diversity of patterns

First of all, the trajectories show a great diversity. As noted in the introduction, Ciompi (1980) and Harrison et al. (2001) stated that there is no given direction in the life-course after being diagnosed with schizophrenia but rather a “striking heterogeneity” (Harrison et al., 2001, p. 516). The overall result of our research confirms this conclusion: men and women who get the diagnoses of psychosis for the first time, can go on with their lives in many different directions, shaping a great variety of trajectories. While Ciompi (1980) used typologies to illustrate different courses, this study follows each of the 384 individuals on aggregate level during the whole 10-year period. This unique approach is grounded on the time-geographical prerequisite concerning the indivisible individual, and a time-geographic visualisation method is used that allows us to closely follow each indivisible individual, year after year without interruption, showing when s/he is subject to different types of interventions, as well as periods with no interventions.

In this discussion, we will highlight the existence of the no interventions sphere. This is based on the time-geographic concept of the indivisible individual, combined with the fact that previous studies focus on interventions, not recognising that, after the institutional care era, periods of no interventions may appear in most people's lives that might not be analysed as an abandonment of persons' need of help. Not being in the interventional sphere for more than a year was our main tool to analyse different patterns. The result was an aggregated pattern of all individuals, some who stepwise left the two spheres of interventions, and others

who were in these two spheres during the whole follow-up period (long-term trajectories). These aggregate patterns pointed out differences between trajectories with long and/or recurrent periods without interventions (sparse patterns) and trajectories with short or no intermissions between interventions (dense patterns).

5.2 Recovery

The discovery that interventions could cease to appear at any time in a trajectory, with no more interventions during the rest of the 10-year period, can be related to the research field of recovery. Recovery in mental health has different definitions (Davidson and Roe, 2007; Slade et al., 2012; Topor et al., 2018). Our data does not give us the possibility to relate them to “personal recovery”, defined as the persons' experience of their situation. Our data can however be related to the concept of clinical or institutional recovery, based on the person's use of mental health services.

The lengths of the follow-up periods that states when a person is recovered has been debated. Although cut-off periods of two years are not uncommon, several studies argue that a five-year period gives a more stable outcome (Laudet, 2007; Topor et al., 2018; Torgalsboen and Rund, 1998). Our data allow us to choose a five-year time span (as used for medical conditions such as cancer). From such a point of departure, 18% of the women and 16% of the men in this study can be regarded as recovered from psychosis. In our study, we consider all types of interventions, and the result shows that being subject to institutional care does not necessarily seem to have a substantial impact on the possibility to leave the interventional sphere at early stage.

Since the follow-up period is as long as 10 years, and the individuals are regarded as indivisible, thereby including periods with no interventions, we might add a new dimension to recovery from psychosis. The sparse patterns reveal that there are no intervention periods “in-between” interventions. Compared to follow-up studies that only pinpoint specific moments (see for example, Harrison et al., 2001; Wiersma et al., 1998), this method brings us a more thorough knowledge about the total situation during a coherent period of life. Even if a person is subject to interventions at the end as well as at the beginning of the longer follow-up period, there could be years without interventions in between. In this

study these intermissions could last up to several years and/or recurrent at several times during the 10-year period. This indicates that a person can get by during substantial periods of time with no interventions, and just occasionally need attention from service providers.

5.3 Spheres and constraints

The three spheres in which people with SMI live their lives, lingering from one sphere to another, are characterised by similar constraints, but with different outcomes. The results from this study give insights about how people who are subject to interventions from the different spheres in the fragmented interventional landscape, meet the time-geographic constraints. We will compare this situation with the old institutionalised care system. There are both different and similar effects of the constraints for an individual's life, in the two different eras of organising SMI-interventions.

As mentioned in the introduction, the former institutions were not only secluded from the rest of society, they also controlled major parts of a person's life (Castel, 1988; Foucault, 1961/1989; Goffman, 1961). Reconnecting to the time-geographic constraints, most aspects of life were performed in one place under authority constraints controlled by one authority, in contrast to life in the rest of society where a manifold of organisations impose various authority constraints. Coupling constraints were reflected in different ways: the patients in former institutions were often far away from home, family and friends and had very limited possibilities to maintain social relationships (Kjellman, 2003). Thus, social interaction mainly involved two social categories: other patients, and staff, strongly coupled to each other. In terms of capacity constraints, expectations that the mental hospitals would improve the psychiatric status and decrease the capacity constraints of the individuals caused by SMI, were obscured by research showing that the effects of hospitalisation enhanced capacity constraints rather than reversed them (Barton, 1959; Wing and Brown, 1970).

A relevant question is whether the sphere of institutional interventions might be regarded as a prolongation of the former institutions. While modern institutional care under surveillance is mostly on a short-term basis (Andersson et al., 2019), the constraints cannot be compared to former institutional care. Supported housing is more a long-term project and may reveal some contradictions on the matter. It may enhance the possibilities of normalised living conditions (as a place of your own) and enhanced access to control your daily life (indicating less authority constraints) and supporting staff may help to decrease capacity constraints (Andersson, 1997, 2016; Ruud et al., 2019). But internal rules (for example participation in activities, compulsory contact with social services/psychiatry, cooperation with staff) indicate the possibility of extensive authority restrictions. Staff will also have knowledge about many aspects of a person's everyday life, with the possibility to affect decisions and ways of living. Authority constraints can thereby still inflict heavily on a person's life and supported housing, originally based on the idea of normalisation, may in that sense possibly be seen as re-institutionalisation (Andersen et al., 2016; Topor et al., 2015). The coupling constraints can also recall the former institutions, as social life can still mainly consist of two social categories – professionals and co-habitants (Andersson, 1997, 1998), although not necessarily constrained by housing authorities

but the person's capacity in terms of resources, for example, poor economy, limiting the possibilities to interact in social life (Topor et al., 2014; Ware and Goldfinger, 1997; Wilton, 2003).

Most people (2/3) in this study have experience of institutions, but for most of them just for shorter periods. This means that they mainly live in a regular home. The common denominator for the regular home is that there are no constraints associated with the home relating to the resident's psychiatric problems. They have the same rights and obligations as other citizens.

The community-based sphere, as well as the no interventional sphere, involves an ordinary home as a base for living, including the surrounding society. The sphere of community-based interventions, then, is a combination of regular living conditions (such as a home) and an intervening society. This weakens the authority constraints (compared to institutional living) and may decrease the influence of capacity constraints on the individual. Community-based interventions involve both psychiatry and social services, and interventions may take place at an office/ clinic as well as in a person's private home, with the intentions to enhance a person's capacities and to eventually manage a life on their own. At the same time, as the interventions might decrease capacity constraints, authority constraints may increase by the presence of officials obtaining increased influence and insights in the private life and home (Andersson, 2009; Chow and Priebe, 2013; Fakhoury and Priebe, 2007; Foucault, 1975; Topor, et al., 2015).

In the sphere of no interventions, people live under similar circumstances and are influenced by similar constraints as other people. Periods of no intervention in the trajectory of a person with SMI can be regarded as personal or private, where authorities connected to the psychiatric problems are not involved. Home is in that sense a protected area. Still, a combination of authority and coupling constraints exist that affect the lives of persons with severe psychiatric problems, who are depending on the welfare system: poor economy (Read, 2010). This influences an individual's possibilities to master social life in the wider society and may strongly affect her/his opportunities to utilise the weaker coupling constraints a life outside institutions could offer, partly due to economy.

As stated earlier, the different types of constraints are mutually related and influence peoples' opportunities to interact and carry out activities (Westermarck, 2003). The individual's room for manoeuvre is in this way regarded as limited (Lenntorp, 1976), regardless of where and how a person lives. Persons with severe psychiatric problems may face specific constraints depending on the spheres in which their lives take place. Authority constraints, such as surveillance, may restrict life in supported housing, but can also influence life in ordinary accommodations with the presence of community-based care and support. Authority constraints in terms of the rules of the welfare system may have effects regardless of sphere, as the poor economy affects the possibility to interact in social life and enhance coupling restrictions.

6. Conclusions

In this article we have stated that the 10-year outcome for persons diagnosed with psychosis for the first time can be substantially diverse, and that it always includes periods of no intervention. This knowledge could have implications on attitudes and expectations among professionals in this

field, in that a diagnosis of psychosis does not necessarily mean life-long interventions. Keeping the perspective of the indivisible individual is the key to understanding how life turns out in the long run for persons with severe psychiatric problems: not only investigating periods of interventions, but with equal interest, examining the sequences without interventions. Only with fully exposed trajectories during the whole follow-up period, using this visualisation method, can this evaluation be carried out.

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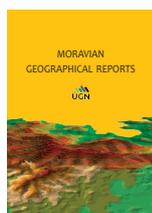
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Meaningful everyday life projects and activities in breast cancer survivors

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Abstract

The time-geographic diary, supplemented by interviews, is presented in this study as a useful method to demonstrate that desirable everyday life projects, with associated activities, may positively influence an individual's quality of life. Breast cancer survivors can experience challenging everyday life activities due to late effects of treatment. Despite improvements in survivorship follow-up programs, we still lack knowledge about how the women themselves prioritise activities that are positive in everyday life. The aim of the present study was to identify everyday life projects that improve the quality of life in breast cancer survivors. The multi-method design included the time-geographic diary method and in-depth semi-structured interviews, carried out with a sample of fifteen breast cancer survivors. The interviews were performed with stimulus from the diary notes and consecutively analysed by directed content analysis. Meaningful everyday life activities were emphasised, and four projects were generated: 1) To do what is good for my body and soul; 2) To create something that is nice and for joy; 3) To keep my family and social network together; and 4) To keep my mind active. These findings can be directed to the development of more individual and peer-driven health care services.

Keywords: Breast cancer survivors, time-geographic diary method, in-depth semi-structured interviews, everyday life, activity, project

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1. Introduction

Everyday life is shaped by what the individual gives preference to and decides to do, in between the struggle to reach desirable goals and handle restrictions (Ellegård and Wihlborg, 2001). In this way, everyday life is individual and personal, and at the same time, it is influenced by other people and by societal structures. Everyday life consists of many activities that can be seen as parts of different projects. In time geography, projects consist of all activities an individual does to reach a goal (Ellegård, 1999). Knowledge about the complexity of human activities can be found, inter alia, in occupational science (Christiansen and Townsend, 2014; Hasselkus, 2006). When performing activities, the individual occupies a 'place in time in a rich tapestry of experience, purpose and meaning' (Christiansen and Townsend, 2014, p. 2). What people do, like making a meal or walking the dog, is often presented as ordinary, normal, or basic and seen to be of little importance (Hasselkus, 2006). Knowledge of what people do can be made more explicit, however, as there is a need to deepen our understanding of how people occupy themselves on an

everyday basis (Christiansen and Townsend, 2014). The daily creation of everyday life is a challenge for most people, and for people living with illness or lasting effects from earlier illness, the challenge is even harder. This study deals with how breast cancer survivors experience activities in creating their everyday life.

2. Previous research

In cancer survivorship there is increasing knowledge about everyday life challenges caused by the disease and late effects of treatment, such as pain, night sweats, disrupted sleep, weight gain, and lymphedema (Jakobsen et al., 2017; Lindberg et al., 2015; McDougall et al., 2014; Ridner et al., 2012; Salander et al., 2011).

Although dealing with late effects is reported to be challenging, changes in life priorities and social support are positive aspects and ways of coping with the illness (Lindberg et al., 2015). Other ways of support in coping are time-relevant information and guidance (Jakobsen et al., 2017), stimulating environments and emotional

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support (Palmadottir, 2010), participating in social activities, regular physical activity, and community-based activities that one finds enjoyable (English et al., 2008). When living with distressing losses after cancer treatment, working toward normalcy may constitute the core process of recovery. The participants in a study by Walker et al. (2015) used different strategies such as taking control of the body and everyday routines, interpreting symptoms as what is to be expected with normal ageing, focusing on the needs of others, expanding their life space, and making plans for the future. A greater sense of normality was associated with higher engagement in valued activities and increased physical and psychological well-being (Walker et al., 2015).

Breast cancer and its treatment may impact women's everyday lives in various ways. In thematic interviews of 39 breast cancer survivors, some women experienced a positive cancer-initiated transformation in their lives, as the disease implied a break from a stressful working life. The experience of being cared for and being acknowledged in a new and positive way helped them to live better lives than before. Others said that the cancer passed without marked traces, and others reported that the cancer made both positive and negative changes in their lives. The positive experiences were improved relationships, a different life perspective, and more meaningful leisure time, while the negative was associated with health problems that restricted everyday life (Salander et al., 2011).

Many lifestyle interventions, often led by health professionals aiming to promote behavioural changes and psychosocial benefits in cancer survivors, have been successful. After a one-and-a-half-day educational program consisting of fitness, nutrition, and exercise related to health, more than 80% of the participants reported increased knowledge of the topic (Stoutenberg et al., 2011). There are several ways to increase exercise frequency in breast cancer survivors, such as emphasising a supportive environment, providing for timely, accurate, and tailored information, as well as knowledgeable instructions (Lavallée et al., 2019). A five-week group session (6–8 persons) focusing on energy conservation strategies, was shown to be effective in decreasing cancer-related fatigue and promoting a healthy lifestyle (Sadeghi et al., 2016), while eight weeks of yoga intervention was found to promote mental, physical, and social health in breast cancer survivors (Puymbroek et al., 2013). In rehabilitation programs, important factors to consider are physical activity, psychoeducation, peer-to-peer support, and follow-up over time (Hauken et al., 2013). In addition, women's needs as occupational beings are important to emphasise (Palmadottir, 2010).

Not all intervention programs have been successful. A systematic review of 26 studies of home-based multidimensional survivorship programs for breast cancer survivors, revealed that the programs had short-term beneficial effects on quality of life and that group-based programs may be more effective than individual programs (Cheng et al., 2017). Although a systematic review revealed that exercise history is positively associated with exercise adherence, we need further evidence on how social and environmental, as well as demographic, psychological, and physical determinants, influence exercise adherence and maintenance. More research is still needed to determine the key components of interventions (Kampshoff et al., 2014).

Group interventions are feasible for many, but individuals have different experiences of coping and control and need to find a balance between different areas in life (Hauken

et al., 2013). Hence, a 'one-size-fits-all' intervention will not cover their needs, and for some cancer survivors, group interventions are not even desirable (Johansen and Dalton, 2017). Evidence of more individual and "low-threshold" approaches that could promote favourable health-behavioural change and health-related benefits are required (Denmark-Wahnefried et al., 2006; Palmadottir, 2010; Johansen and Dalton, 2017). More knowledge about how breast cancer survivors themselves prioritise activities in their everyday lives could be essential for this purpose. Time-geography, in which activities and projects are central concepts, can be a suitable "tool" to gain a deeper understanding of the meaning and experiences of people's everyday lives (Ellegård, 2019). The primary aim of this study was therefore to identify important everyday life projects that improve the quality of life in breast cancer survivors.

3. Theoretical background

Since occupational science is an interdisciplinary research discipline, with a goal to explore and understand the nature, meaning, and sociocultural structures of occupation (Jarman, 2014), researchers from fields like anthropology, economics, geography, occupational therapy, political science, psychology and sociology are dealing with studies of everyday life. They all suggest, however, that occupations emerge from the routine and everyday aspects of humans daily living, and they all contain the same assumption, namely that everyday living is actually a very complex process (Jarman, 2014).

In situations where too many or too few daily activities lead to an imbalance, the result can easily create a stressful situation of dissatisfaction – and an activity balance may be needed. Håkansson et al. (2017) describe activity balance as a dynamic concept moving between more or less activities, where the individual influenced by surroundings self must decide the degree of balance. By defining activity balance, the individual's perception of having the right amount and variation of activities are central (Wagman et al., 2012). Backman (2014) emphasise the extent to which the individual is able to organise and participate in desirable activities in accordance with his or her aspirations and values. Moreover, what must be considered as valued activities can differ over the course of a lifetime and depends on cultural conditions. A literature review of occupational science describes how occupational balance depends on the individual's perception of the variation and the right amount of activities (Wagman et al., 2012). Time spend in activities will therefore be insufficient knowledge when studying activity balance, because we need to know the subjective individual meanings of the activities (Håkansson et al., 2017).

To understand and describe activity balance in the present study, knowledge from studies of Backman (2014) and Wagman et al. (2012) will be important in order to understand the individual's perception of an everyday life activity balance. These studies also clarify the importance of the individual's experience and their values of what activities are worth spending time on. The way of prioritising time is often connected to the individual's identity. In the present article, the concept of activity is used similarly to that of occupation, as in disciplines such as time geography.

In occupational science, identity is often connected to purposeful and meaningful activities (Jarman, 2014; Townsend, 1997). What people do in everyday life is understood to be linked to the development and expression of identity (Christiansen, 1999; Laliberté Rudman, 2002),

which means that the individuals will express themselves and their identity in various activities, at work, in leisure time, and at home with family and friends. Challenges performing desirable activities, as after illness, may therefore imply difficulties in expressing identity, as before the disease.

4. Design and methods

The study adopted a multi-method design, including the time geographic diary method (Ellegård and Nordell, 1997) and in-depth qualitative interviews (Gubrium and Holstein, 1997). As a first phase topics from the diary were used as a starting point and as stimulus material for the interviews. In the next phase interviews were conducted based on themes prepared in an interview guide (Anguera et al, 2019).

4.1 Recruitment and participants

‘Everyday life in cancer survivors’ is a qualitative sub-project of a long-term (median 8 year) clinical follow-up study of breast cancer patients at Trondheim University Hospital. The patients were recruited from the Health Region Middle Norway, which represent one of four health regions in Norway (see Fig. 1). At the outpatient clinic, the consulting oncologist invited the patients consecutively to participate. Participation in the present sub-study involved writing diary for one week, including the weekend, and subsequently agreeing to participate in an individual interview. The data collection for this part took place in 2013.

After receiving the completed diaries, the researchers called participants and made appointments for the interviews. There was no selection of participants based on any specific characteristics. The interviews were consecutively

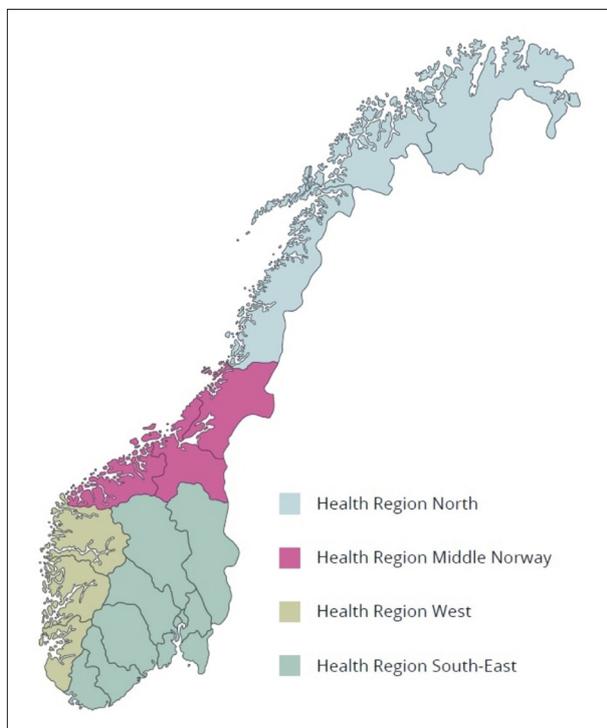


Fig. 1: The four health regions in Norway
Source: authors' elaboration

analysed, and participants were included until saturation of information was reached (Malterud et al., 2015). Fifteen women participated¹.

4.2 Generation of data

4.2.1 The time geographic diary method and in-depth interview

The time geographic diary method focuses on what people do and the connection between time, space, and activity, where the activity is the main focus (Ellegård and Nordell, 1997; Magnus, 2019). It illustrates routines as well as preferred and chosen activities in a social and geographical context. The method relies on a diary notebook that is filled out by participants, where all activities from one midnight to next midnight are reported. The diary illustrates a rhythm shaped by sleep and meals, and diaries from different individuals are, of course, not identical and cannot easily be compared. They do, however, give a picture of characteristics of the everyday life of the individuals, which is worthy for many purposes. The diary notebook has columns for time, what the diarist does (activities), where the diarist acts (places), and with whom (togetherness), and at last the diarist's own comments.

The participants were asked to list activities in such a diary notebook for seven consecutive days and to write down comments during the day, starting when getting up in the morning. Each diary was read thoroughly to obtain specific knowledge of each participant's everyday life activities in context. The intention was to discover what activities the individual found important in everyday life to be able to live a good life.

Based on knowledge from the diary week, a semi-structured interview was conducted with each diarist, either at the participant's home or at an arranged meeting place. The interviews started with a recap of the information in the individual's diaries. The main question in the interview guide was: 'Tell me about your everyday life today', followed by the question, 'In what ways has breast cancer influenced your everyday life?'. These main questions were followed by questions about how the women chose to use their time, changes in daily activities, and the meaning of different elements in the environment. With the intention of capturing the individual's projects, diary notes on activities interpreted with a special meaning were given particular attention during the interview. The interviews were all conducted by the authors, electronically recorded, and literally transcribed.

4.2.2 Analysis of the interviews

The interviews were analysed by a directed content analysis (Hsieh and Shannon, 2005), which starts with existing research on the phenomenon under research or a theory as guidance for initial codes. The goal of a directed approach to content analysis is to validate or extend conceptually a theoretical framework or theory. Existing theory or research can help focus the research question. It can provide predictions about the variables of interest and about the relationships among variables, thus helping to determine the initial coding scheme or relationships between codes.

In the transcribed interviews, what was found to be central and desirable activities and restrictions (Ellegård, 2019) in everyday life, were manually highlighted and then gathered

¹ Ethics: The main study was approved by the Regional Committee for Medical and Research Ethics (REK midt id 13760). All participants gave their written informed consent after being provided oral and written information.

into a short-synthesised text from each interview. Further analysis of each synthesised text identified desirable activities that were grouped and given names: 1) 'Physical activities'; 2) 'Creative activities'; 3) 'Activities for the brain'; 4) 'Activities in the home'; and 5) 'Activities together with others' (see Tab. 1). The presented activities were influenced by different kinds of challenges, and they held different meanings for each individual. Various combinations of desirable activities were performed by the individual women in order to achieve the goals for their projects.

The identification of projects was carried out by combining the activities from the diaries and interviews, with the meaning of these activities expressed in the interviews. For example, notes in the diary about walking the dog together with a friend were elaborated in the interview, talking about how this activity was performed, where and with whom, and the meaning of it. The meaning could be the importance of physical activity to gain more energy, to be together with a friend, or to just be with the dog.

In time geography, projects are associated with all the different activities an individual does to reach a goal. There can be minor goals such as 'To give a party for friends', or more extensive such as 'To build a new home for my family'. From the analysis of the diaries and interviews, this study resulted in the identification of four general projects: 'To do what is good for my body and soul'; 'To keep my family and social network together'; 'To create something that is nice and for joy'; and finally, 'To keep my mind active'.

4.3 Methodological considerations

Malterud, Siersma and Guassora (2015) introduced the concept 'information power' as a guide to adequate sample size for qualitative studies. Information power depends on the aim of the study, sample specificity, use of established theory, quality of dialogue, and the analysis strategy. The aim of this study was quite broad, and the sampling of participants was consecutive. That is, the participants may have rather different experiences besides being treated for breast cancer. Both these conditions indicate the need for a larger number of participants. On the other hand, the study is supported by theory (time geography); the interview dialogue is strong with experienced researchers; and the data collection includes both diary notes from seven consecutive

diary days and in-depth qualitative interviews. As such, we felt that fifteen participants were enough to meet saturation for the aim of this study.

5. Results

Although some of the women had to handle an everyday life that was heavily influenced by the previous cancer treatment, and others reported no problems due to treatment, they all emphasised everyday life activities and the meaning of them. The following text will elaborate on how these activities constitute the projects. The participants are described in Table 2.

5.1 To do what is good for my body and soul

This project consists of different kinds of physical activities. The activities were experienced as positive and necessary for the cancer survivors in one way or another, whether they liked them or not.

The women's narratives dealt with physical activities even though the participants did not use the term 'physical activity' themselves. They went for walks in the neighbourhood, the forest, and the mountains, walked the dog, and went out for bicycling, swimming, yoga, and a fitness centre. Physical activities were expressed as something they had always done and a way that they had always lived their lives. For Maya, fitness for seniors, aerobic, and bicycling prevented pain and stiffness and made her feel better:

"I have done physical activities all my life and was a handball player until I was 50. I have always been a bit tuff, been a ski jumper and participated in most physical activities as young. I like challenges and it is good to be pushed, because sometimes it can be a problem to go out. It is much harder to go out exercising alone than being dragged out by someone else". (Maya)

Mindfulness helped her sleep, and both yoga and mindfulness prevented pain and oedema after the lymph had been removed. To motivate herself to be more physically active, she decided to participate in a big city run.

Other participants went swimming because they felt good with it, and socialising afterwards was as important as the exercise itself. Meeting people over coffee or fruit, they could

Physical activities	Creative activities	Activities for the brain	Activities in the home	Activities together with others
Going for walks	Doing knitting	Doing crosswords	Doing housework	Meeting friends at the café
Dancing	Singing in a choir	Doing Sudoku	Making food	Walking to the kiosk talking to people
Picking berries	Gardening	Reading books	Making cakes for Christmas	Meeting the sewing club
Cycling	Doing embroideries	Reading newspaper	Painting the walls inside	Meeting others at the centre of the cancer association
Running	Playing in a corps	Looking at the TV	Doing groceries	Going to church
Spinning	Making it cozy by lightening a candle, drinking a glass of wine	Keeping up with news	Rehabilitate the cottage or house	Going to work and meeting others
Swimming	Taking photos		Cleaning the gutter	
Pilates	Picking flowers			
Yoga	Making drawings			
Walking the dog				

Tab. 1: Groups of desirable activities from the diaries and interviews
Source: authors' field research

Participants	Age	Living with someone or alone	Children	Work/Retirement
1 Elisabeth	48	With husband	3	Disability pension
2 Pamela	56	With husband	2	Working 50%
3 Bridget	56	Alone	1	Working 100%
4 Evelyn	59	Alone	2	Working 100%
5 Elsie	59	With husband	1	Working 100%
6 Cora	63	Alone	0	Disability pension
7 Maya	66	With husband	2	Disability pension
8 Susan	67	With husband	2	Retired
9 Cilia	68	Alone	2	Retired
10 Anna	70	With husband	1	Retired
11 Patty	72	With husband	3	Retired
12 Karen	73	With husband	2	Retired
13 Sophie	74	Alone	2	Retired
14 Brenda	76	With husband	1	Retired
15 Daniela	86	Alone	2	Retired

Tab. 2: *The study participants*
Source: authors' field reports

share experiences of cancer treatment. In this way, training involved the possibility of sharing experiences and holding on to friendships.

Elisabeth knew that if she was to survive, she had to be fit. She realised that she needed someone to help her in getting out, and she got a dog:

“And that was very smart, because when you get out, and you have warm clothes and coffee you can be out for many hours. We do not go fast, but for many hours. Walking generates so much positivity”. (Elisabeth)

Elisabeth did former physical activities in different, adjusted ways, such as co-training with a group of other women:

“... and I can manage to be behind. I just must accept that they run away from me. Doing interval training is ok because then we meet during pauses. Just coming out in fresh air. It makes me see everything in a lighter way”. (Elisabeth)

Others started doing physical activities because professionals argued that it was good for their health and could prevent cancer recurrence. They did spin, walking, bicycling, and running together with colleagues and friends. The social aspect of training and the importance of being fit to be able to engage in other activities were important arguments for continuing.

Not all participants were motivated for physical activities. Due to side-effects of treatment, some found it too difficult to start doing any physical activities, even when they knew they should. For some, the door was hard to force open.

This general everyday life project deals with different kinds of physical activities that were good for body and soul for those performing activities in these projects. The meaning of the activities was connected to how the cancer survivors had spent their lives previously, as well as to well-being and socialising, and the activities helped them to manage their lives, which promoted energy for other desirable activities.

5.2 To create something that is nice and for joy

The aim of this project is to create something that is nice, that involves joy and benefit.

For the oldest women, engaging in handicraft was necessary to get a feeling of doing something useful for the home, for family members, and for others. Also, it was a way of spending time. Daniela and Sophie knitted lap rugs for their grandchildren, and Daniela explained that she had problems being inactive. Susan knitted to fill her everyday life with something positive, and Anna talked about how she had always enjoyed doing handicrafts. She concentrated on voluntary work, selling handicrafts to get money for social events at the nearby nursing home. When asked about the meaning of these activities, she said:

“The day I can't use my hands, it will be difficult. Of course, I could read, doing crosswords and other different things, but handicrafts give me something. I feel that if I just sit there doing nothing (in the house), at least I do this. I do something that is useful to say it like that.” (Anna)

Doing handicraft had mixed meanings. The participants managed the activities; the results were nice and positive for other people; they filled the time, and for some it was combined with socialising.

Other creative activities involved similar meanings, such as photo, choir, playing an instrument, making drawings, and picking nice stones and flowers. Cilia started to sing in a choir: “I do it once a week. It is so nice, and I have met a lot of nice people there”. Bridget stopped playing an instrument when she married because her husband did not like it. After she got breast cancer and was divorced, she started to play in a corps again, and she loved it.

For Elisabeth, the fact that she had to stop working meant that she experienced new activities. She met new people and had to involve herself in shaping a new everyday life, finding a new passion, and finding time to rest. She attended a photo workshop and said:

“I have found something that gives me meaning and that involves social meeting places. It means that I meet 20 to 25 other people that are as interested in this as I am. We are making a new network and I get new friends. Now I find myself as a very lucky person having the possibilities to do what I like”. (Elisabeth)

During the last years Elisabeth had spent time renovating the house, doing sewing, drawings, and other projects at home or in the cottage. Although she was active and enjoyed a lot of activities, she talked about the need to rest and to adjust the activities due to her capacity. Maya had to learn how to rest in a different way than before and started to do new things such as crosswords and looking at television in the morning.

Although most of these women talked about activities they enjoyed doing and that involved a special meaning for them, such as being creative or socialising, a few talked about the things they would like to do but were unable to initiate. Elsie said that she was full of energy and added:

“I should have had a hobby. I have thought about the Red Cross, may be doing some voluntary work. I will make them a call and ask what that will involve; I have a lot of energy.” (Elsie)

This general everyday life project included creative activities, which the women prioritised, activities they were used to doing or liked to do, and activities they had just learned about or picked up from former life. The activities often involved gifts to others, socialising, and ways of getting rest.

5.3 To keep the family and social network together

This project was of great importance, as well as demanding. The participants expressed the importance of being cared for when they needed it, spending time with family and friends, and being open about diagnosis, treatment, and the situation afterwards. Although Evelyn loved the way friends and family had supported her, she sometimes felt that there were too many visitors and social situations she had to attend. Sometimes it was difficult to have time for herself. Spending time with and caring for children can be strenuous, but it was a priority for those with grandchildren. That was also the case when gathering the family for dinner. Susan wrote comments in her diary when she had spent time with others: ‘so good to be together’, ‘lovely’, ‘indescribably’, ‘lovely people’, and ‘cosy’. She said:

“I have always been a social person, but I use a lot of energy to be nice, to make it a bit cosy. And they (the family) knows me, and they can see, and they say that I should take a rest, go and lay down for a while. But I don’t want to do that, I would so much be like the rest of them, like it was before”. (Susan)

Even though Susan had support from her family in encouraging her to take care of herself, it was difficult for her to rest. Despite less energy she kept up with what she had always done; she invited friends and family, and she felt exhausted before they arrived. She said:

“I expect a lot from myself and it easily gets too much with a lot of people talking and children running around asking for equipment for drawing ... I do it because I am a family person wanting to have the family around me. I have always been the one that have gathered them and done everything when there was something to celebrate. I feel that it is more strenuous now, I put off and get bad conscience about it”. (Susan)

Inviting family and friends involves different kinds of activities regarding preparing and cleaning up. Meeting family members at other places such as a café did not demand that much energy. Although friends were important, Pamela said:

“I think I am a bit different now than before. I can feel that I don’t take that much contact with the ones that don’t give me anything. In a way I am a bit careful. My life is too short to have people around me that only suck out my energy”. (Pamela)

The women negotiated with themselves as to whether they should go on doing activities that exhausted them. Pamela refused to do them and decided not to spend time with people who made her tired, and Susan said ‘yes’ more often than she thought was wise. Reducing the number of initiatives could make the women feel better, but it also represented a risk, as fewer social gatherings could have consequences for their social networks.

In this general everyday life project the women were concerned about the importance of gathering family members. For some, these social situations had always been their responsibility, and they wanted this to continue. Less energy and extended need for rest made this more challenging. Some of the participants continued meeting important family and friends outside home, which for them were less demanding.

5.4 To keep my mind active

This project involved activities that emphasised concentration or learning, and for some this meant challenging capacity restrictions. Sudoku, crossword, as well as reading newspapers and books, were activities they had liked to do earlier. The activities were ‘good for the brain’ or ‘keep the brain in good shape’, which were new reasons for keeping up with them. To manage many of the activities, concentration and silence in the room was necessary, and they experienced the activities as more time consuming than before.

For some, reading newspapers was a way of using the brain, and more importantly, it was necessary to be able to participate in conversations with other people. Not being up to date meant that these social situations were difficult for them. Concentrating and remembering what they had heard or read was a challenge for some, and Pamela expressed:

“I remember very little, names and so on. Maybe it is my age, but ... and the concentration is not the same. If this happened after the treatment I don’t know, but I think it was so”. (Pamela)

Concentrating to manage some activities demands energy and a willingness to persevere despite challenges. Most of the participants continued with these activities because they appreciated them, but also because keeping the brain active was important to be able to do other desirable activities, such as discussing the news with friends or enjoying a book.

This general project dealt with activities that stimulated concentration and remembering. Although these activities were a continuation of what they had prioritised before illness too, central now were the importance of being able to participate in conversations with other people.

6. Discussion

Experiencing a life-threatening illness involves changes and readjustments in life. The women facing late effects after treatment talked about changes in life priorities, lifestyle readjustments, and specific strategies, as found in other studies (Lindberg et al., 2015; Salander et al., 2011; Volker, 2013). The women in the present study spent time on a myriad of prioritised activities, and from a time-geographic perspective we identified four different projects:

1) To do what is good for my body and soul; 2) To create something that is nice and for joy; 3) To keep my family together; and 4) To keep my mind active. Among the activities in these projects, there were desirable activities (which were identified from the diaries, see Tab. 1), and other activities that were not perceived as desirable. Each of the four projects contains activities with a special meaning to the individual and has therefore to be obtainable. Performing activities can be an expression of identity and therefore act as a support in the process of redefining and recognising oneself. The women in the present study needed to adjust their expectations in order to find a balance that enabled them to continue with meaningful activities. Based on these findings, two distinctive features of the daily life of the participating women will be discussed: Redefining identity in activities; and Activity balance.

6.1 Redefining identity in activities

As activities are linked to identity (Christiansen and Townsend, 2014), a person's individual identity may be challenged by illness, making it difficult to keep up former activities at work, home, or during leisure time. The four projects indicated how important activities had strong connections to the breast cancer survivors' individual histories. Additionally, the projects displayed how the women wanted to present themselves in a positive way and how this ability was an important element in the feeling of wellness and having a good quality of life.

The projects also identified stories of activities that link together earlier life with today's everyday life for cancer survivors. Susan continued to invite the family for dinner, while others continued reading or caring for grandchildren, even though it was strenuous. Despite bodily restrictions, the continuation of activities enabled the women to present themselves in a desirable way and can be understood as a process of redefining and shaping their individual identities. These processes have been described as ways of experiencing continuity in life (Palmadottir, 2010) and working toward normalcy (Walker et al., 2015). In the latter study, a greater sense of normalcy was associated with higher engagement in valued activities and increased physical and psychological well-being. The women in the current study appreciated activities that presented them as the same person they were before the cancer, a desire expressed by statements like 'to be like others' and 'to be like before'. The four projects are expressions of how activities helped the women to experience lives as near to their former lives as possible. The importance of being perceived by others as having an identity beyond that of a cancer survivor is also described in other studies (Lavallée et al., 2019; Ridner et al., 2012; Walker et al., 2015).

The importance of socialising during activities was clearly expressed through the four projects, for example, singing in a choir, doing activities with grandchildren, chatting after physical training, and doing handicrafts as volunteer work. Since activities are connected to identity, performing desirable activities while socialising may therefore be helpful in the process of redefining oneself after cancer. The importance of socialising through activities is in line with other studies. Some of the women in a study by Palmadottir (2010) found it rewarding to be active in cancer organisations, contributing to the well-being of other people in similar situations, while Lavallée et al. (2019) found that how meeting others in similar situations encouraged the women to continue with organisational work, share experiences, and receive support.

Supportive environments are also shown to be important in the healing process after cancer (English et al., 2008; Palmadottir, 2010; Volker et al., 2013).

6.2 Activity balance

The four projects represented prioritised, but also negotiated, activities. To find a balance in daily activities, one should be able to organise and participate in accordance with one's wishes and values (Backman, 2014). Due to the late effects of treatment, however, some activities were hard to follow, and the participants had to argue with themselves about how to manage these desired but demanding activities. The breast cancer survivors in the present study found it challenging to balance activities that had a special meaning, such as spending time with family members, which often resulted in an overuse of energy and exhaustion. Similarly, the young adult cancer survivors in the study of Hauken et al. (2013), struggled to find a balance between everyday activities, and they experienced that some activities were important in order to build capacity, while others were prioritised to increase social participation. Such priorities could be essential for establishing activity balance in accordance with one's wishes and values, as emphasised in Backman (2014). Activity balance involves leaving some activities out and replacing them with others. Finding balance in activities is an individual process, and each person must decide what that means for her or him, as shown in our study when Elisabeth had to stop working as a banker and started working with photography. Changes in activity balance are described as learning to live under new conditions and re-evaluating one's capacity in different activities (Hauken et al., 2013), which may involve a reorientation of everyday life, as found in Jakobsen et al. (2017) and Salander et al. (2011). Working towards a balance in daily activities involves the risk of eliminating desirable projects with activities that confirm identity or socialising activities with significant persons. Doing more activities than advisable could for some prevent these losses but would not be a sustainable strategy. Involving activities that are both enjoyable and provide opportunities for rest, for instance, the project 'To create something that is nice and for joy', could be a way of balancing the capacity of everyday activities as well as confirming former identity.

6.3 Strengths and limitations

The present study illustrates how time-geographic diaries supplemented by interviews, can be suitable to highlight desirable everyday life projects with associated activities that positively influence individuals' quality of life. First, the diaries help people to remember their everyday activities in detail and was thus a perfect tool to facilitate the interviews. Second, the diaries themselves may also clarify critical elements that have to be handled in order to live good lives. The time-geographic diary method emphasises the individual's own description of everyday life and is of raising consciousness of the person's own life, and the constraints the person faces. Prioritised activities often represent part of the women's histories and are therefore essential in the process of redefining identity after cancer treatment. Social relationships in activities seem to be fundamental, along with the individuals' negotiating in order to achieve the optimal activity balance.

Our sample was breast cancer survivors that struggled with different health issues. Results from our qualitative study cannot be generalisable to the entire population of breast cancer survivors. The results can be generalised to

similar settings, however, in which adult women struggle with various chronic conditions, and thus be applicable beyond the breast cancer survivor setting.

The present study has some limitations. Most of our participants were retired and only one third had active work lives. Thus, our identified projects and activities are most likely valid for an older breast cancer survivor population. Despite that, many elements in these projects are universal and probably generalisable to the youngest survivors: we encourage future work to explore similar research questions in a younger or working-age breast cancer population.

7. Conclusion

To summarise, with the help of time-geographic diary notes and in-depth semi-structured interviews, this study identified four projects of everyday life activities for breast cancer survivors: 1) To do what is good for my body and soul; 2) To create something that is nice and for joy; 3) To keep my family and social network together; and 4) To keep my mind active. The projects hold activities that represented important aspects of the women's lives and identities. Due to treatment effects, some of the participants had to stop doing activities as before. To be able to do what was most important, they had to balance the activities in a manageable way. Findings show how these four projects with meaningful and prioritised activities define and redefine identity and challenge activity balance in ways that improve quality of life.

The implications of our findings may be directed to the growing need for more individualised follow-up programs after breast cancer and the need for rethinking how follow-up could be sustained. The concept of patient empowerment in cancer follow-up can be conceptualised as mastery, skills and knowledge (Johnsen et al., 2017). When developing interventions or actions, based on patient involvement, however, one should ensure that the interventions are not only efficient, but also feasible to all patients – not only the well-educated with a strong social network (Johansen and Dalton, 2017). Rehabilitation stays are valuable for many breast cancer survivors (Juvet et al., 2009), but unfortunately, they are not accessible or even desirable for others. Knowledge of how everyday life projects with a balance of desired activities can stimulate positive identity and good quality of life may provide building blocks for developing more individual and low-threshold healthcare services. Such services could even be facilitated by peers (Freund, 2016, Johansen and Dalton, 2017), and thus be available for all breast cancer survivors, either alone or in combination with existing rehabilitation programs.

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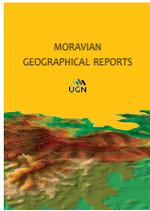
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To fear or not to fear? Exploring the temporality of topophobia in urban environments

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Abstract

The concept of topophobia has been known in Geography for decades. Places which evoke fear in people's minds can be found in almost every city. The perception of fear within an urban environment shows a certain spatio-temporal concentration and is often represented by fear of crime. The meaning of topophobic places, however, derived from the experience of fear of crime changes over time, and thus can alter the usual patterns of population behaviours in relation to time (in the time of the day and over longer periods) and space. A spatio-temporal understanding of these changes is therefore crucial for local decision-makers. Using data from the Czech Republic, this paper deals with the analysis of topophobic places, and is based on an empirical survey of the inhabitants of four cities, using the concept of mental mapping. In contrast to most similar geographical studies, the paper emphasises the temporal dimension of the fear of crime. The results have shown that over time there are significant differences in the meanings of topophobic places, and they have demonstrated the necessity of taking local specifics into account. The paper shows how the intensity of and the reasons for fears vary, depending on time and place. In general, the results provide support for the idea of place as a process and contain useful information for spatial planning and policy in urban areas.

Keywords: temporality; fear of crime; topophobia; mental maps; meaning of place; Czech Republic

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1. Introduction

For decades, safety has generally been considered one of the basic human needs (Maslow, 1943). One's feelings of safety can be disturbed by many elements and one of them is undoubtedly the fear of crime. With respect to the reduced feelings of safety which stem from fear of crime, the changes in an individual's decision making and behaviour occur in both space and time. Those concerns are subjective to a considerable extent and dependent on many aspects of human life. Therefore, every individual can feel a different intensity of danger in a particular environment. Moreover, fear of crime is currently perceived as a serious society-wide issue (Hale, 1996; Salem and Lewis, 2016) and as such it has become the topical subject of much scientific research. (e.g. in economics: Bannister and Fyfe, 2001; in psychology: Gabriel and Greve, 2003; or in criminology: Gray et al., 2011).

Research on the fear of crime fundamentally discuss the issue from two main perspectives. The first deals with population views and socio-demographic profiles. Regarding this aspect, it is important to emphasise the differentiated and oft-examined perception of fear on the basis of gender

(Pain, 2001; Tandoğan and Topçu, 2018) and age group (Adu-Mireku, 2002; Clememte and Kleiman, 1976). Furthermore, there are studies which focus on the fear of crime as felt by people of diverse social status. To illustrate this, there can be social segregation within socially diverse residential districts. This can lead to the so-called 'gated communities', where only each particular district's residents can gain access (Sakip et al., 2018; Tomášek, 2010; Tulumello, 2015). For these studies that deal with the fear of crime based on population perceptions, there are works based on distinguishing the extent of fear of crime among both native and immigrant inhabitants (as in Canada – Weinrath, 2000; and Denmark – Glas et al., 2019).

A second perspective focuses on the meaning of the physical environment as a determining factor in the fear of crime. Such papers seek to clarify the safety/hazardousness of municipal parks and public green places from the points of view of those affected by fear of them (Jim and Chen, 2006; Suau and Confer, 2006). Another aspect that Atkins et al. focused on in their study (1991) is street lighting, also with connections to the fear of crime. Cozens

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et al. (2003) likewise highlight typical locations in urban spaces (explicitly train stations and their surroundings), whose physical appearance often causes unpleasant feelings, and which can lead to people repeatedly referring to the locations as ‘places of fear’.

Geography, then, plays a significant role in research into the concept of fear of crime (see e.g. Stasíková, 2011), because such fears can be seen as experiences which are always connected with particular places. Owing to such experiences, a place gains identity and this meaning can influence people’s spatial behaviour. Because of the close interconnection between fear of crime and place, some geographers (e.g. Little et al., 2005; Pain, 1997 and 2000) have tried to find specific rules, or rather patterns, in this relationship.

Most of these studies, however, rarely mention one important variable which significantly forms the perceptions of a place: time and its dynamics. The need for a common adjustment of time and space is emphasised in the work of Ellegård (2019, p. 3), who highlights the “importance of taking time and place into consideration when reflecting on and investigating human activity”. Despite the fact that there are observations of the fear of crime or of crime itself, partially interpreted with regard to temporal (Solymosi et al., 2015) or seasonal (Andresen and Malleon, 2013) circumstances, there is no sufficient framing of this concept in time. In this paper, we would like to address this shortcoming.

Based on data from the Czech Republic, the main aim of this contribution is to explore and identify the spatial and, more particularly, the temporal dimensions of fear of crime, understood as a specific urban experience that informs the negative meaning of a place. For this purpose, several research questions (RQ) were established:

- RQ1: Is it possible to discover relevant changes in some identified places over a long period of time, on the basis of lived space-time experience?;
- RQ2: Is it possible to discover relevant changes in the identified places during the day, on the basis of everyday space-time experience?; and
- RQ3: What are the most common reasons for the perceived fears, and are there differences in their structure in space and time?

Our research employs three approaches: first, place as a process and as a constantly human product (Pred, 1984); second, topophobia as the expression of negative meanings of a place (Tuan, 1975); and third, time geography (Ellegård, 2019). Fear of crime as such is always set to a specific place and time, both of which help to identify the consequences and context, and because of that a deeper analysis of issues connected to fear of crime can be carried out. We grasp place as an entity that always represents a human product (Pred, 1984), and as an entity of individually felt significance, values and meanings (Tuan, 1977). The temporality of place is also considered in order to understand time dynamics (see e.g. Hägerstrand, 1983, or Muliček et al., 2015). According to Ellegård (2019, p. 3) the “time-geographic approach ... helps in analysing how one and the same need is satisfied differently depending on where, when and by whom the activities are performed”. Therefore, time geography creates a convenient “tool through which it is possible to reveal the phenomena and relationships in everyday life” (Ira, 2001, p. 243).

As stated by Jichová and Temelová (2012), it is not only criminality itself but also the population’s perception of fear of crime, which are important topics with potential impacts

on the policies of municipalities. Therefore, monitoring the presented phenomenon in space and time can help in the decision-making sphere by, for example, producing conceptual documents focused on precautions against criminality and on urban development. If the correct identification of a problem is accomplished, it is possible to focus the potential precautions more precisely and effectively (with regard to space, time and phenomena) in order to rectify situations in problematic locations.

2. Theoretical frame of the research

In this theoretical section of the article we introduce and elaborate on the principal concepts related to the research. We commence with the concept of place, not omitting the problematics of spatiality and temporality. We then focus on people’s experiences of place and the effect of those experiences on the creation of meanings attributed to that place. Subsequently, the relationships between place, experience, meaning and time are discussed. This is followed by a basic typology of the meanings of place, and the role of crime on the meanings of place is also discussed. In the final part of this section we discuss such matters as how the negative meanings of places can affect human behaviours within urban settlements, and the policy implications of knowing about places that have been attributed with negative meanings based on the fear of crime.

2.1 Place, experience, meaning and time

Place is one of the key geographical concepts. Despite this, there is no general acceptance of the understanding of place amongst geographers. For example, Malpas (2018) states that place is often taken for granted. On the other hand, it is a challenge to find a detailed analysis of the concept of place. Thus, we lack a widely acknowledged definition of place. Instead, according to Paasi (2002, p. 806), place is, in geographical language, conceptualised flexibly, and a definition depends on the context to which a place is related, while also emphasising the aspect of local scale that has for many years fuelled the general understanding of place. A different way to approach the concept of place is elaborated by humanistic geographers, who have not fixed place on to any scale. Rather, they have emphasised the importance of human experience for an understanding of place. Experience plays a key role in the process of attributing meaning to a place, since experience drives the process (Daněk, 2013). A meaningful place as such cannot be understood as a simple physical location, since it can be conceptualised as a constantly human product (Pred, 1984). Thus, when analysing the spatiality of a place one also has to consider the socially constructed dimensions of that place. For instance, Tuan (1977) conceptualised place as an organised world of meaning and added that space is transformed to place when it gains definition and meaning. As well, Relph (1976) sees place as a result of the spatial concentration of human actions, experiences and intentions.

An urban place should be defined not only through its spatial attributes and social dimensions, but also through time. In his seminal contribution, Pred (1984, p. 279) rejects the idea of place as a static entity “that emerges fully formed out of nothingness and stops, grows rigid, and is indelibly etched into the once-natural landscape”. Rather, he employs the temporal dimension which emphasises place as a process. Cresswell (2008) also addresses the aspect of time when he discusses the temporality of place. In other words, the affiliation of a place to a particular spatio-temporal system

should also be taken into account (Muliček et al., 2016). In relation to time, two conceptualisations could be employed: first, linear time or the one-way flow of time; second, cyclical time or the cyclical flow of time.

Linear time is a form of mechanical clock-time not anchored in spatial, social or economic activities (Golledge and Stimson, 1997; Muliček et al., 2015). With respect to linear time, a place is seen as a pause in time instead of an unchanging reality (Liu and Freestone, 2016). A place serves as a container of linear time: personal memories and biographies are bounded in a specific place, where the life paths of specific people take place (Pred, 1984). As a consequence, there are experiences from past times sedimented in a place, because it is in that place that these experiences are spatialised, materialised and memorialised. The idea is broadly discussed by Malpas (2018, p. 184), who states: “The past cannot be grasped independently of place. Only in place can there be a creature capable of grasping past, present or future, and only within the compass of place can there be the spatio-temporal ordering of things on which a grasp of the past depends”.

The second conceptualisation of time, cyclical time, is not understood as being in binary opposition to linear time. Rather, it is complementary to linear time, as cyclical time also determines the temporality of a place. Cyclical time draws on the repetition of spatial actions by human beings and on their routines (Crang, 2011; Golledge and Stimson, 1997). These are organised at various frequencies, such as on a daily, weekly, monthly or yearly basis. Repetitive actions and routines expressing cyclical time are necessarily bonded to particular places, spatially localised entities, objects and processes. This is especially true concerning routes used daily, conceptualised by Pred (1984, p. 281) as set of “actions and events consecutively making up the existence of an individual”. Hence, both concepts of time define the temporality of a place that is not merely characterised by its spatiality. From this point of view, a place becomes a unit of time-space.

Gaining knowledge about a place could also be seen as a function of time, since it requires some period of time to acquire that knowledge (Tuan, 1977). This acquisition is made up of a large amount and a wide range of experiences that have occurred over years (linear time), and which have also been reproduced and transformed day after day, week after week, etc. (cyclical time). The learning about places and subsequently assessing them through experiences with them is accumulated, reproduced and transformed over time, and this leads to the different meanings that humans attribute to certain places, whereby these meanings are reproduced (sedimented) and transformed (changed). Tuan (1975) defined two basic categories in assessing the importance of a place. The first is topophilia, the second is topophobia. A topophilic place has positive meanings so it is seen as a safe, pleasant, popular and desirable place. On the other hand, a topophobic place is connected with negative meanings and so it is subsequently understood to be dangerous, unpleasant and repulsive, and is consciously avoided. It is possible in many cases for both these contrasting meanings to be contained within one place. Accordingly, a third type of place importance can be added, complementary to the two mutually dichotomous categories. This can be defined as topo-ambivalence (Brisudová et al., 2020), based on the duality of a place. Positive and negative meanings attributed to various places, even to one specific place, originate from the experiences gained over time by individual residents, i.e.

from people who differ in such socio-demographic factors as gender, age, social class, education and length of residence (Golledge and Stimson, 1997). Beside time, these factors also influence the character of the meanings attributed to particular places.

2.2 Fear of crime as a specific experience of an urban place

Fear of crime is one of the urban experiences that essentially determine the negative meaning of place. Urban residents may fear certain places and this could be due to past and recent events (e.g. violent attacks in a certain place) sedimented in their biographies, current and past physical appearances of a place (e.g. brownfields), and information from secondary sources such as media and conversations with other people. Fear of crime can be both rational, corresponding with real crime, and irrational, not reflecting the actual crime situation (Bannister and Fyfe, 2001). This raises the question of which aspects mainly determine that the fear of crime is experienced in a particular place. Ceccato (2020a, p. 24) emphasises the importance of people’s individual characteristics: physical and psychological abilities, gender, age, ethnicity, sexual, social and economic statuses are named. Previous research (e.g. Pain and Smith, 2008) has provided evidence suggesting that women, the elderly, members of ethnic minority groups, those who belong to the LGBTQI (i.e. lesbian, gay, bisexual, transgender/transsexual, queer/questioning and intersexed) community, and the disabled and disadvantaged, are more prone to experience fear of crime more intensively.

All in all, when one thinks about fear of crime, the intersection of multiple individual factors has to be thoroughly considered (Pödör et al., 2016). Beside individual aspects, the environmental structure of urban places must also be taken into account, since it underpins fear (Cozens and Love, 2015; Shamsuddin and Hussin, 2013). Loukaitou-Sideris (2009) identifies dark environments, poor guardianship, lack of maintenance, physical and social disorder and unkempt and abandoned buildings, as important environmental entities contributing to higher levels of fear of crime being attributed to places. Ceccato (2020b, p. 39) adds that “poor maintenance or signs of physical deterioration of an area are thought to be more important determinants of fear of crime than the actual incidence of crime”. Both physical and social disorder and its forms in an urban environment are described as elements of the ‘disorder/incivilities’ hypothesis, which points to different forms of incivility which are perceived to be warning signs of a potential criminal threat leading to fear of crime (Doran and Burgess, 2011, p. 38).

Fear of crime, as well as any other urban experience, develops over time. The temporal dimensions of fear of crime can be approached through a broader process of ceaseless reproduction of social and cultural forms, the formation of biographies and the reproduction and transformation of the physical structure of place (see Pred, 1984). The one-way reproduction or transition of physical appearance and long-term path-projects in urban places defines linear time. That is why the fear of crime can differ between generations, and length of residence in urban space can also affect the intensity of fear of crime (Andreescu, 2013; Glas et al., 2019). The regular repetition of physical appearance and short-term path-projects define cyclical time. Hence, the intensity of fear of crime can be determined by the regularly changing phases of the day (Jichová and Temelová, 2012; Pantyley et al., 2017), week (weekdays, weekend dichotomy) or season

(Semmens et al., 2002). As a result, both complementary conceptualisations of time can influence the reproduction, transformation and disappearance of fear of crime in one particular urban place.

People respond to the fear of crime in various ways. Among other responses, Grohe et al. (2012) described the following important reactions: residents may avoid certain places at particular times and may modify their daily routines and lifestyles, or they may generally withdraw from participation in urban life. As early as fifty years ago, Stuart (1969) similarly evidenced the ability of fear of crime to force residents to change their ways of life, more specifically to abandon large parts of American cities and change their 'natural' patterns of behaviour. Moreover, in addition to the viability of neighbourhoods, it is acknowledged that behavioural responses to the fear of crime impact on physical and mental health (Curtis, 2012; Latkin and Curry, 2003). All responses are accompanied by changes in the spatial and temporal dimensions of the behaviours of urban residents. The spatiality and temporality of the behaviour of urban residents can be seriously affected and altered by their responses to the fear of crime attributed to particular urban places, and all changes in the spatial behaviour of urban residents can consequently underpin a decrease in the quality of life and overall well-being within an urban space.

It is important to realise that crime and the fear of crime are two qualitatively different phenomena (Minnery and Lim, 2005). Based on previous research (Doran and Burgess, 2011, p. 190; Ivan et al., 2020) it can be declared that there is a close relationship between the fear of crime and real crime cases. On the other hand, the presence and spatial distribution of topophobic places based on the fear of crime does not necessarily correspond to the level of real crime. Tulumello (2015, p. 258) points out that "all across the Western world violent crime rates have been dropping dramatically since the early 1990s, at the same time as fear of crime has been growing to the highest levels ever recorded". Hansmaier (2013) emphasises the important impact of (especially local) media and social networks when considering fear of crime, as it presents information about local crime and other incidents which could then develop a fear of a particular place. Although the occurrence and spatial deployment of topophobic places based on the fear of crime does not always have to correspond to the level of real crime, it could be used as a valuable and practical tool for the identification of problematic places within an urban space (Lopez and Lukinbeal, 2010).

The identification of topophobic places as determined by the fear of crime, as well as an understanding of their physical structure and a thorough knowledge of the topophobic meanings of those places caused by a fear of crime, have policy implications as does the role played by the temporality of these meanings. The topophobic meaning of a place fueled by fear of crime can be reduced through improved planning and policing, which should result in the sustainable spatial behaviour of urban residents. In a more general way this idea is formulated by Marshall (2016, p. 201). In her contribution she makes the following concluding points: "City-makers such as planners, landscape architects, architects, and politicians need to understand people and their civic relationship to open space and facilitate their public life. This ultimately improves the physical urban amenity and the social sustainability of the 21st century city". Urban safety, described by Ceccato and Lukyte (2011) as a dimension of urban sustainability, is an ongoing process that could also be

improved through appropriate urban planning approaches. There is a range of techniques that contribute to the needs of contemporary urbanism (Tulumello et al., 2017). One of them is Crime Prevention Through Environmental Design (CPTED), which aims to provide a safer urban environment. This concept has already been implemented in many cities and should lead to a reduction in fear of crime and a strengthening of the sustainability of cities (Cozens and Love, 2015; Shamsuddin and Hussin, 2013). Information about the spatial deployment of places perceived in the context of fear of crime undoubtedly have a valuable character. The advantages of knowing about fear of crime hot spots for urban development purposes have been positively evaluated, as in the Community Safety Mapping Project in Sydney (Doran and Burgess, 2011, p. 221). Through avoidance maps created by the residents' perceptions/fear of crime, the police identified new areas of disorder that were previously unknown.

3. Data and methods

3.1 Methodological points of departure and the methods of research

Our research is grounded in the concept of mental maps, which are the result of perception processes. More precisely, we employed the narrowed problematics of perception that are used in geography (Siwek, 2011). Conceptualised as such, it is understood to be the perception of space. For our contribution we draw upon a definition by Golledge and Stimson (1997, p. 190) who wrote that perception is the immediate apprehension of information about the environment. This primarily happens via one or more of the senses. Secondary environmental information is taken from the media and through hearsay via communication with fellow humans. When thinking about perceptions one should also include matters of collective cultural beliefs, values and aesthetic judgments related to the natural and human-made environments (Wills, 2009). Thus, in the case of perception, it is a consequence of mental activity that arises from the registration of actual environmental stimuli and the art of imagination. The images resulting from this process are stored in the human mind and are recalled as needed by the individual. It is the circumstances in which arise the need to use the concept that shape its actual form.

One of the above-mentioned images could be mental maps (Gould and White, 2005; Tuan, 1975) resulting from the processes of perception. Mental maps can be understood as a construct arising from internal psychological processes. External influences, however, cause this construct to be a complex formation also to have a significant influence on the form of the mental map. Mental maps are important because of their features. Most importantly, mental maps serve as sources of information for decision-making processes, which affect the spatial behaviours of people within the environment (Lloyd, 1989). Besides, mental maps can be understood as a kind of memory device that enables people to carry out common mental practices that promote self-confidence in subsequent physical actions (Tuan, 1975). Last, but not least, their other function is the ability to be focused on geographic knowledge. Just as 'real' maps are a means of structuring and storing knowledge in memory, mental maps are a means of organising spatial data. According to Tuan (1975), mental maps can serve geographers as the cartographic representation of peoples' attitudes toward places.

From the methodological point of view, mental mapping is generally considered a practical research method in geographical environmental perception (Gould and White, 2005; Pánek, 2016). According to Frantál et al. (2017, p. 238) “mental mapping is a valuable tool for understanding how humans perceive and reflect their environment”. The convenience of the mental mapping application in data collection from urban space research has been demonstrated in case studies from all over the world, regardless of the type of research: it can be a systematic way to study the meanings of places (Osman, 2016); an expansion of creative industry in a city (Brennan-Horley, 2010); a contribution from its inhabitants to a city’s development (Ghioca, 2014); or the identification of places identified as causing fear (Curtis, 2012).

Mental maps should be understood as a general concept. When emotion and its spatial context become the object of imaging or drawing, such mental maps are called emotional maps (Perkins, 2009). According to Pánek (2018, p. 19) “emotional maps are a spatially accurate mode of data collection and use a base map as a background for respondents’ drawings”. Through an emotional map, an individual is able to visualise images of places to which she/he attributes certain emotions and meanings from her/his own (or mediated) experiences. The mental map (in the form of an emotional map) was thus chosen as a suitable tool for obtaining information about places which produce a fear of crime – not only about their location, but also about their other attributes (e.g. causes of fear or times when people felt fear in a place).

3.2 Case study area

The Czech Republic has long been considered one of the safest countries in the world (Institute for Economics and Peace, 2020). Despite this, it is important to evaluate feelings of fear of crime because they influence and, to some extent, contribute to the overall quality of life. For the present study, a case study area was determined as the territories of the four largest cities in the Olomouc Region. The Olomouc Region is one of fourteen NUTS3 units in the territory of the Czech Republic and is situated in the eastern part of the country (see Fig. 1). The four cities by population are Olomouc with 100,663 inhabitants, Prostějov with a population of 43,651, Přerov with 42,871 inhabitants and Šumperk with a population of 25,836 (CZSO, 2020).



Fig. 1: Location of the Olomouc Region and cities under study. Source: ArcČR, 2016; authors’ processing

All four cities are administrative centres of their districts (LAU1 sub-regions) and Olomouc is also the headquarters of the NUTS3 regional government. Unlike the other three cities, Přerov has a high ratio of unemployed to employed people (see e.g. Frelich, 2019). Moreover, Přerov differs in that it also has a high ratio of Roma people and several so called excluded locations (e.g. Čada et al., 2015; Topinka and Janoučková, 2009). These facts are important regarding the topic of the study, as they allow us to explore and compare the results and possible differences between Přerov and the other cities in the study.

3.3 Research design

The basic design for this study was survey research, hence the data source was administration of a questionnaire. A pilot survey was carried out in March, 2019, in which the main goal was to create more precise and understandable questions for all respondents. The questionnaire was implemented in several waves and the first took place in April, 2019. In the course of this wave, a face-to-face interview was carried out by thoroughly trained students, who addressed respondents in the four largest cities of the Olomouc Region – Olomouc, Prostějov, Přerov and Šumperk. Afterwards, an on-line version of the questionnaire was prepared, and consequently the survey underwent the CAWI (Computer Assisted Web Interviewing) method until January 2020. Moreover, this version of the questionnaire was disseminated by the criminality prevention managers of the Olomouc region and the affected cities. The information about the ongoing survey was shared on the cities’ websites and in the local and nationwide public and private media. The last wave of the survey was conducted in January 2020, in order to make the sample representative (in relation to the respondents’ gender, age and place of residence).

As stated, a combined method was used when collecting the questionnaire responses, and the choice of face-to-face interviews can be considered as a mix of random and quota selections. In the case of the online version, self-selection was evident. Despite the fact that this is not a probability selection, the authors consider it as representative because of the partial probability quota choice of the respondents. In total 3,205 questionnaires were collected in the four analysed cities (811 in Olomouc, 508 in Prostějov, 1,410 in Přerov, and 476 in Šumperk). The limit in the minimum number of respondents, as given by the Raosoft company online calculator¹ for the selection set computation, was exceeded in all cases. If there was no information about a respondent’s gender, age or place of residence, the questionnaire was discarded from the analytical part of the sample. The largest number of these discarded questionnaires was in Přerov (23.5%), the lowest number was in Šumperk (13.9%). The final structure of the sample is represented in Table 1.

It can be said that the respondents’ structure by gender, age and place of residence (evaluated at the level of the city parts) usually corresponded to each particular city’s population structure; see the assessment of the χ^2 test on the level of significance $\alpha = 0.05$ (Tab. 1). Nevertheless, in order to obtain more precise results, it was agreed to attach weights to the particular respondent groups according to their basic demographic characteristics (weights² were constructed on

¹ <http://www.raosoft.com/samplesize.html>

² The variables of gender and respondent’s age were considered for weight determination. The respondent’s place of residence was not included in the computation because of the absence of data (it was not possible to divide some of the less populated settlement units by gender). Moreover, it is apparent from the χ^2 test results that the respondents’ structure by their place of residence in all cases corresponded to the adult population structure of the particular cities.

Age group	Olomouc (84,097 inhabitants)			Prostějov (37,067 inhabitants)			Přerov (36,827 inhabitants)			Šumperk (22,009 inhabitants)			
	Total	Out of		Total	Out of		Total	Out of		Total	Out of		
		M	F		M	F		M	F		M	F	
15–19	49	27	22	25	15	10	79	43	36	38	20	18	
20–29	223	112	111	78	33	45	281	134	147	58	30	28	
30–39	95	50	45	71	32	39	242	123	119	58	24	34	
40–49	82	42	40	73	34	39	172	92	80	60	28	32	
50–64	92	43	49	87	41	46	192	98	94	83	41	42	
65 and more	96	36	60	99	38	61	112	48	64	113	48	65	
total	637	310	327	433	193	240	1,078	538	540	410	191	219	
p-value (χ^2 test)	gender, age	0.000		0.457		0.000		0.302		0.302		0.302	
	city part	1.000		0.700		1.000		0.898		0.898		0.898	

Tab. 1: Sample structure by gender and age supplemented with χ^2 test results assessing the potential difference of the sample structure and population for the variables of gender, age and place of residence

Notes: The bold font represents p-values that are lower than the chosen level of significance $\alpha = 0.05$, which means that the sample structure statistically significantly differs from the population structure. The numbers in brackets below the names of the cities represent the number of inhabitants aged 15 or more as of 31 December 2019.

Sources: CZSO (2020); authors' processing

the basis of the ratio between the representation of the stated population group in the sample and in the whole population). The sum of the weights assigned to all respondents was in accordance with the total number of respondents (see Tab. 1), i.e. only for those not discarded for the incompleteness of their answers.

The questionnaire included closed and semi-closed questions, but the most important part was the map work. In this part there were two questions in which each respondent plotted where she/he did not feel safe at the moment, and where she/he did not feel safe 10 years ago. Beside the map plotting, the respondent had the task of specifying the reason for her/his choices, as well as quantifying the level of fear on a 3-point scale, and deciding in which part of the day she/he feels the fear (day, night, throughout the whole day). As it was important to keep working with the reasons for their plotting, several categories were created with respect to the use of the quantitative methodological approach. The reasons were subsequently sorted into respective categories.

As with other studies working with the mental maps of respondents (e.g. Curtis, 2012; Doran and Burgess, 2011; Pánek et al., 2018; Šerý and Šimáček, 2012), the subsequent processing of the respondents' map plotting was carried out in the GIS environment. The level of perceived fear declared by the respondent was assigned to the final outputs in the form of a weight dedicated to each of the marked places of fear. The final areas of perceived fear – or 'fearscapes' as they are called by Tulumello (2015) – were defined by the sequential overlapping of the particular respondents' outlines and their sum (i.e. the sum of their weights) in a vertical progression. In addition, final areas were distinguished by the extent of the fear and the time (from both linear and cyclical perspectives), when the location is perceived by the respondents to be problematic. In order to have a clear arrangement of the output visualisation, the final maps contain only those locations which were

marked by at least 3% of the respondents, but 100% is not equal to all the respondents who took part in the survey. It only included those respondents whose answer to the question of whether or not they felt fear of crime in their city of residence was not an absolute no (i.e. the possible answers were; definitely, more likely, probably not). In the retrospective investigation into places that produced fear of crime 10 years ago, respondents who had not lived in the city for at least the last 10 years³ were not included in the analysis. For the representation of a perceived fear level, a Fear of Crime index (FoC) was used in the map outputs. This index represents not only the share of respondents who marked the location, but also takes into consideration the perceived fear level:

$$FoC\ index = \frac{\text{respondent weight} \times \text{perceived fear level}}{\text{number of respondents} \times 3} \times 100 (\%)$$

The FoC value of 100% means that all respondents who should have marked the locations of perceived fear in their particular city did so, and they mentioned the highest level of fear of crime, i.e. 3.

3.4 Methodological limitations

The authors of this study are well aware of some of the limitations. First, it is necessary to mention an approach to data collection using the combined techniques of on-line and face-to-face questionnaires. The primary technique of data collection was on-line questioning which, however, had to be supplemented by face-to-face questioning due to the very limited use of the Internet by older people⁴. Verification of compliance in the results achieved by these different data collection techniques (while maintaining the same questionnaire) was not possible due to the different age structures of respondents in the on-line and face-to-face surveys.

³ Also, respondents aged 15-19 were not included in this case, as their ability to respond to questions about the situation 10 years ago is very limited, to say the least.

⁴ The percentage of people aged 65 and over who did not use the Internet was 67% in 2014 (Hedvičáková, Svobodová, 2017).

The use of the level of perceived fear as a weight in the calculation of the FoC index also might appear to be a potential methodological shortcoming. Although it was possible to proceed with the transformation and adjustment, the authors, following the example of some other indices used (e.g. education index), decided to keep the ordinal character of the variable as a weight, in order to highlight areas with the highest levels of perceived fear of crime. It is obvious that in light of the above information, the interpretation of the FoC index results must be carried out carefully and in accordance with the chosen calculation.

There is also the questionable accuracy of the respondents' plotted places of fear. Although the plotting map background was intentionally presented in the form of an uncluttered topographical map, many of the respondents had difficulty with orientation in their own city, and this makes it harder to find the perceived places of fear. Another limitation was the absence of similar research carried out in the studied cities since that would have made it possible to see the changes in the meaning of places from a long-term perspective. Therefore, it was necessary to ask the respondents about their perceived places of fear 10 years ago. Naturally, this question was sometimes seen as difficult one, requiring respondents to recall their feelings of fear in their cities a decade ago. Hence, it is probable that some of the respondents were not able to recall all the problematic places or the reasons why they were problematic. Verification of this thesis is possible only through long-term research, requiring similar surveys to be conducted.

4. Results and discussion

First it has to be said that not all respondents reported a fear of crime in their city. In this matter, each of the examined cities differed from the others. While almost 19% of the respondents in Olomouc and Šumperk stated they had no fear of crime, that proportion was 14% in Prostějov and 4% in Přerov. Regarding this perception, more men than women chose this option in all the cities. As regards age, respondents aged 65 or more were undoubtedly the largest group (the ratio of this age group's respondents who did not feel the fear of crime was almost double in all the cities, in comparison with the figures stated above). That result contradicts several (mostly older) case studies which, in contrast, highlighted a positive correlation between age and the intensity of the perceived fear of crime (Box et al., 1988; Clememte and Kleiman, 1976). On the other hand, there are more studies whose results demonstrate that this relationship is not clearly relevant (Chadee and Ditton, 2003; Sakip et al., 2018), as with this study. Furthermore, another relevant explanation can be found in the Jichová and Temelová (2012) study, which refers to some inhabitants (primarily the older ones) who are not able to assess the fear of crime completely, owing to their limited outdoor activities. As mentioned in the previous Section, all the subsequent analyses were carried out using a case unit composed of respondents who felt at least some fear of crime in their city, i.e. those that could make an outline of the places of fear on the enclosed maps.

4.1 The temporality of the topophobic meaning of places from a long-term perspective

Based on the data analysis, there are places which demonstrated stability, as well as those with certain changes in their meaning over the course of time. Focusing on the linear perception of time analysis, it is possible to discover

a deterioration in the situation throughout all the explored cities when compared with 10 years ago (see Fig. 2). The situation is expressed not only with the frequency of the respondents' outlines (the colour scale), but also often with an increased level of perceived fear (the purple line delimiting the areas with the FoC index value > 10%).

From the spatial point of view, the defined locations in Olomouc in both time periods were seen to be mostly stable, but in relation to time, a change in the level of perceived fear was observed, i.e. the situation had worsened over time. While the FoC index had a maximum value of 8.6% ten years ago, recently it reached 17.6%, and the locations with an index over 10% covered an area of approximately 3.7 ha. As for the most critically perceived locations, the first was the main train station, including the space in front of the building. The city's parks were also featured (mostly Smetanovy sady).

In the other cities there was a clear change in the meaning of places, both in space and time. For example, in Prostějov more places of fear were currently identified than the situation 10 years ago. For the most distinct changes, almost the whole wider city centre appeared to be a place of fear. Another new situation was the spread of the area of fear from the city centre to the east, towards the main train station. There was also a slight deterioration in the situation in Kolářovy sady, including the identification of a new place of fear in the surroundings of the Městský Pond (south-west of the centre). Another new place of fear was the Spojenců Square (north-east of the centre). In the city district of Vrahovice fear of crime was felt in the surroundings of the lodging house (north-east of the main train station). On the other hand, there is no longer a place of fear in the area on the map's western edge (U svaté Anny), where there used to be a Romany colony, and there was also a slight improvement in the situation in Husovo Square (to the east of the centre). As for the detected FoC index values, at present only a subtle increase of approximately half a percentage point to 14.1% was observed at the most critical location (i.e. the main train station). Regardless, the extension of the area of fear is obvious. In contrast, in another location largely perceived as a place of fear (Husovo Square), there was a modest decrease in the FoC index, as well as a reduction in the size of the area of fear, especially in its western section.

In Přerov, the area of fear is much larger than it was 10 years ago (from 84.8 ha ten years ago to 345.6 ha today). Moreover, the extension of the fear of crime area was, on the basis of the respondents' opinions, identified as the largest in all the examined cities. Apart from the areal spread along almost the whole area of the compact city south of the river, a new place of fear was defined on the north side of the Bečva River: the Velká Dlážka housing estate. There is also an apparent extension of the area where respondents declared a higher level of fear. The core of the most critical location ten years ago was the immediate surroundings of the main train station (especially Husova and Škodova Streets north of the station). Presently, beside this site, a bus terminal (situated south-east of the main train station) has become part of the core. While the maximum FoC index value was 25.8% ten years ago and the area of FoC index > 10% was an estimated 16.1 ha at that time, currently the maximum of the FoC is 37.9% and the area's FoC > 10% is approximately 41.3 ha (2.4 ha with the FoC > 30%).

Certain changes can also be observed in Šumperk. Over time there has been an increase in the number of identified places of fear and a rise in the local level of perceived fear.

Compared with the situation 10 years ago, part of the city centre was newly identified as a place of fear (mostly the historical centre's north-east part), and a new place of fear was found in the Dolní Temenice housing estate district (north-west of the centre). Regarding the perceived fear level, the maximum FoC index value 10 years ago was 9.1%, while currently it is more than double at 18.8%. The most critical place in this respect is the southern part of the city park (Sady 1. máje), situated north of the main traffic terminal, including the train and bus stations. The area where the FoC > 10% is approximately 2.1 ha.

4.2 The temporality of the topophobic meaning of places based on everyday experience

With respect to the respondents' outlines, they had the opportunity to express whether they felt fear in a place during the day, during the night or throughout the whole day. Although there were three possible choices, the data definitely showed that the locations perceived as places of fear only during the day, accounted for only a marginal percentage of the outlines. Moreover, in none of the studied cities was there a location where

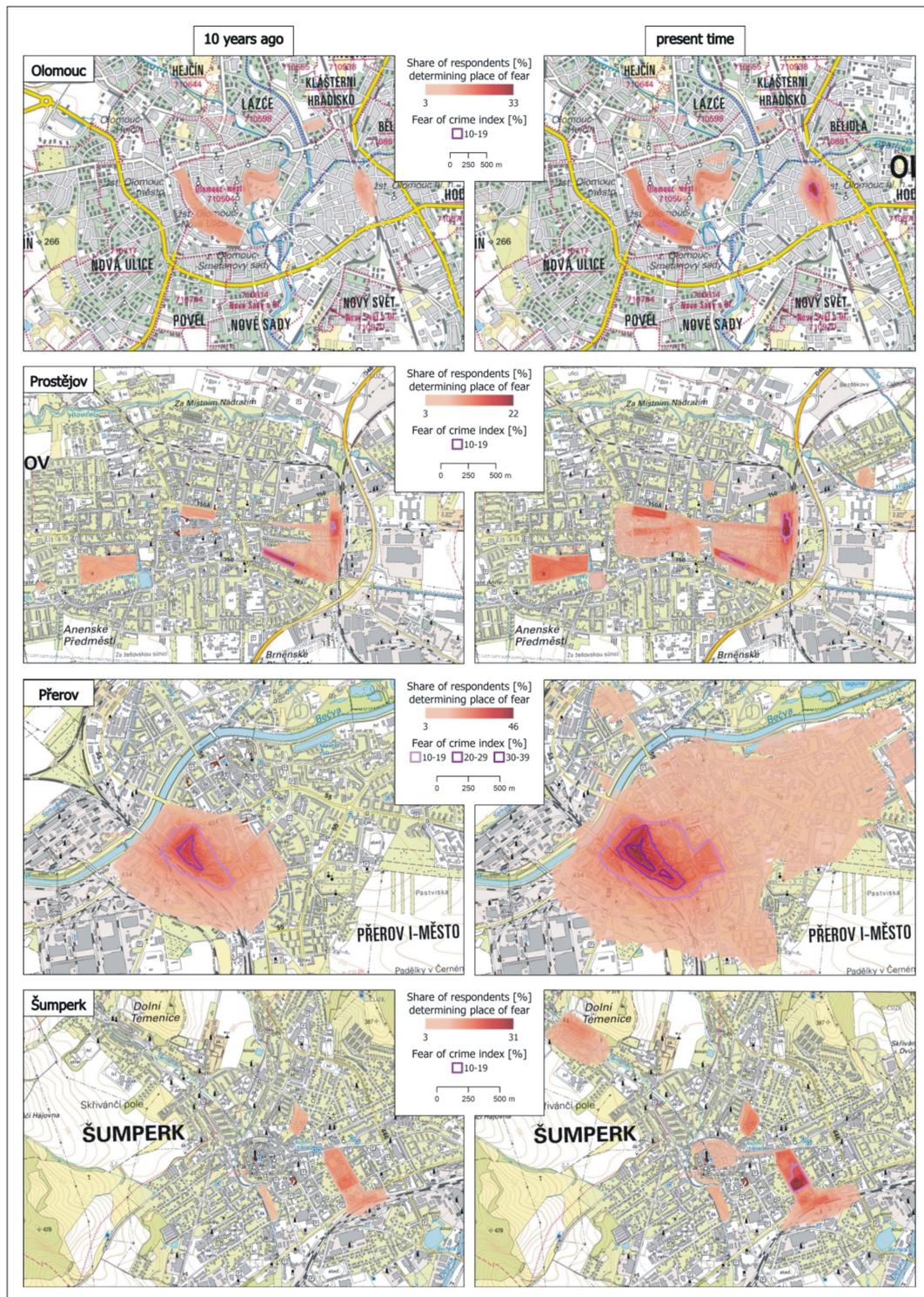


Fig. 2: Topophobia based on the experience of fear of crime – long-term differences
Sources: authors' survey and processing; background map © ČÚZK, 2020

at least three percent of the respondents agreed in their outlines. For this reason, there are no maps of places of fear for the day in Figure 3.

Comparing the occurrence of places of fear in the studied cities, a few similarities can be observed in Olomouc, Prostějov and Šumperk with respect to the daily hours. A visible increase in the outline frequency was detected in several clearly defined locations during the night in all these cities. Those locations were mainly parks and green squares, and in Prostějov and Šumperk this included the spaces in front of the train stations (the space in front of

the train station in Olomouc was also perceived as one of the most critical places after dark, although a little less than over the whole day). As for the perceived fear level expressed by the FoC index, each of the three cities had different results when comparing the night hours with a whole day.

An FoC > 10% during the night was only detected in Prostějov (10.1% at the main train station) and additionally, only in a restricted area of about two dozen square metres. In Olomouc, an FoC > 10% was not recorded during the night hours, but it did emerge in the results for the whole

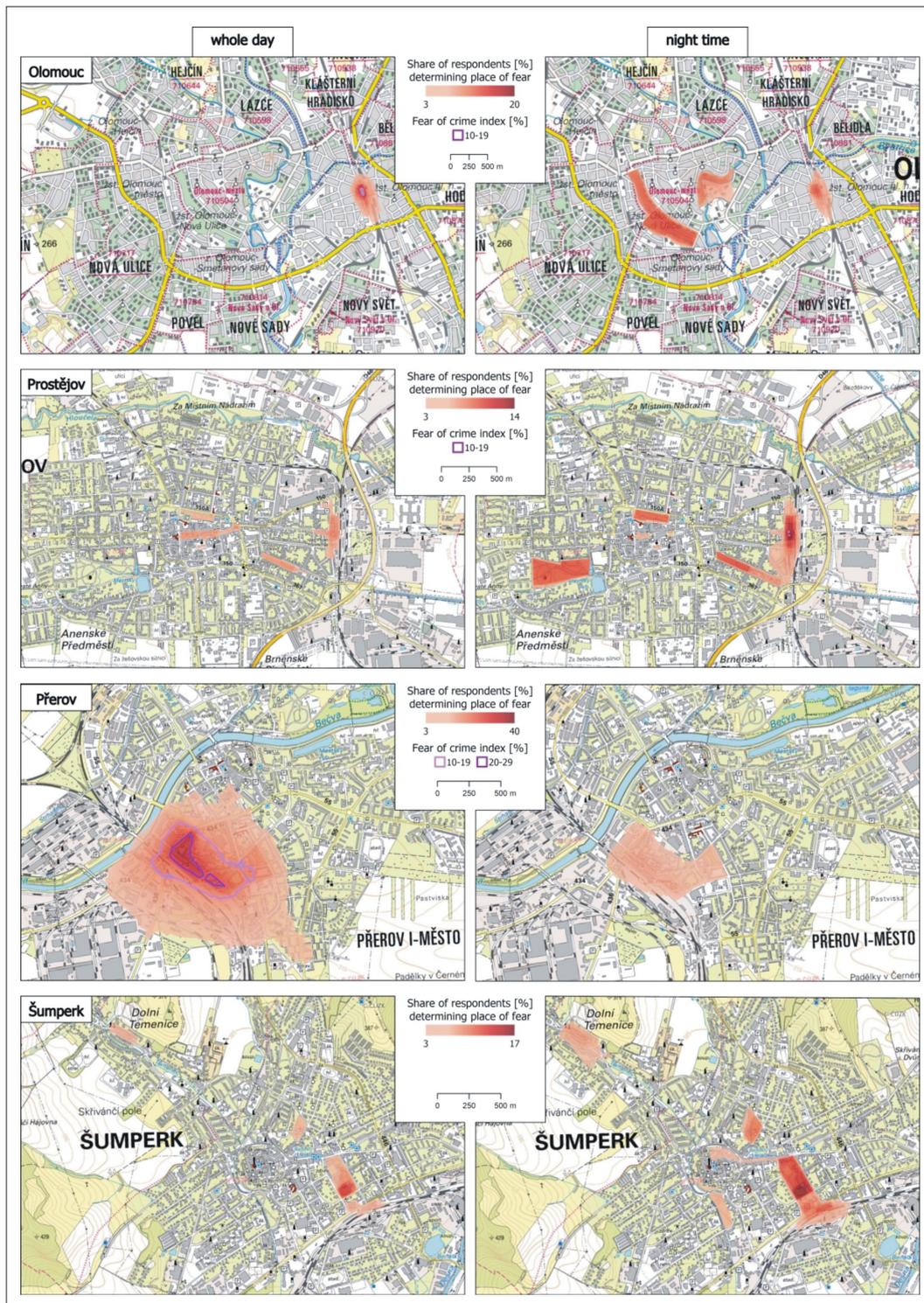


Fig. 3: Topophobia based on the experience of fear of crime – differences within the day
Sources: authors' survey and processing; background map © ČÚZK, 2020

day (11.1% over an area of 0.2 ha by the main train station). Unlike Prostějov and Olomouc, in Šumperk an FoC > 10% was not observed anywhere over any period of the day.

In striking contrast, in the fourth studied city, Přerov, the findings substantially differed from those in the other three. Not only was there no increase in the places of fear during the night, but the highest relative frequency of the outlines was at least double the value found in the other cities. Furthermore, Přerov had the highest level of perceived fear of all the studied cities (29.1%, not far north of the train station). The extension of the FoC > 10% area accounted for about 25.8 ha (4.6 ha with the FoC > 20%).

There are also similarities between our research and other studies from post-socialist European cities. Pődör et al. (2016), in their research on the city of Nagykanizsa in Hungary, also identified the city centre as an area of fear of crime. A study from Lublin in Poland (Pantyley et al., 2017) presents similar types of places with similar fears of crime to the cities included in our research. Moreover, the Lublin study shows differences between the night (bus and train stations, city parks and cycling paths along the river were mentioned most) and the day (areas surrounding blocks of flats, city gates, vicinities of social buildings were often mentioned).

4.3 Types of places of fear of crime and their temporality

Based on the temporality of the topophobic meanings attributed to places, we identified four types of places. These specific urban places are likely to represent various environments in particular cities. Concerning the spatiality of the first type of place, where the topophobic meaning is changing over linear and cyclical time, our findings from Olomouc and Šumperk suggest that city centres are examples of such a type. Similar findings concerning city centres are also described in the study by Pánek et al. (2018). As for the second type of places, where topophobic meaning only changes over linear time and is stable over cyclical time, some residential neighbourhoods in Prostějov and Šumperk can be seen as examples. Municipal parks can be recognised as typical representatives of the third type of place, where topophobic meaning only changes over cyclical time and is stable over linear time. This corresponds with the Jim and Chen (2006) and Sreetheran and Bosch (2014) research results, which deal with the perception of municipal parks and public green areas as potential places of fear of crime. Nevertheless, the time factor has proved to be an important element here: while from the linear time point of view there is stability in the meaning of place, the view of daily periods can cause the perception of the parks to be more reflexive, since parks gain their problematic labels mostly after dark (see the results from Olomouc). All four cities under study have a historical centre surrounded by residential and industrial districts. Only in Olomouc, however, is the historical centre surrounded by municipal parks. Therefore, it can be difficult for the inhabitants of Olomouc to avoid them while walking to and from the city centre. For this reason, the parks can be perceived as dangerous places along the important routes between the city centre and people's homes. Although it is possible to avoid the parks while going to and from the city centres in Prostějov and Šumperk, even there the parks represent significant places of fear. Still, when compared to the other cities, the parks in Přerov (except for the public green place in the Svobody Square – east of the main train station) do not play an important role in forming places where there is a fear of crime.

The typical representatives of the fourth type of identified places are the train stations, where a strong topophobic meaning is stable over time. This agrees with the results of the work by Cozens et al. (2003), which characterised train stations and their closest surroundings as problematic places, stable in time. In contrast to the study of Cozens et al., however, we do not see the main reason being the poor physical appearance of the environment, but primarily it is the people in the train stations' surroundings. The case of Přerov is the clearest of all, since the time aspect regarding the image of the train station's location is insignificant for the city's inhabitants. Based on their own experiences, the place has a strong negative meaning, and it is mostly connected to unpleasant interactions among diverse social groups.

4.4 Reasons for the dependence of perceived fear on time

The specific reasons why the respondents felt a fear of crime were classified into 15 categories; the last category included all the previously unclassified ideas. While creating the categories, the authors took into account knowledge from other research (specific population groups – e.g. drunk people, the Roma; the physical environment and its characteristics – e.g. parks, insufficient lighting) and the clearly repeated statements of the respondents (e.g. re: socially unadaptable people). Most categories were based on socially related factors. Here, we have evidence in support of the argument made by Sandercock (2005), who states that the expressions of fear of crime are fear of others. Similar findings were also defined in the research on the Kings Cross locality in Sydney, where 16 environmental cues which mostly trigger fear of crime were defined (Doran and Burgess, 2011, p. 221). Intoxicated people (with drug- and alcohol-related issues) are the most serious cause of an increase in fear of crime. These findings are in line with Pődör et al. (2016), who found that the frequent movement of Roma minority groups generates a strong fear of crime among the inhabitants of Nagykanizsa in Hungary.

Since the representation of some categories in the particular cities was relatively few, in comparison with the main reasons for the fear of crime, only the most common reasons are shown in the graphic representation. For the periods 10 years ago and now, the top five most frequently stated reasons were chosen. As they were not the same (neither in relation to cities nor to periods of time), nine are presented in Figure 4.

The structure of the reasons also varied in time and space. Comparing the current reasons for the fear of crime and those of 10 years ago, it is obvious that most were mentioned less in the past (Fig. 4), although there are a few exceptions: the greatest difference in the percentages points in the direction of 'situation improvement' was seen in Šumperk (reason: socially unadaptable people) and in Prostějov (reason: the Roma people). The only reason respondents highlighted more 10 years ago in some of the cities, was the fear of being attacked (in Olomouc and Prostějov). The contrast, however, was only minimal. In addition, in Olomouc both noise and poor lighting were mentioned 10 years ago, therefore certain improvement can be inferred in these factors. A deterioration can be seen based on many of the reasons given for fear of crime, however, because most were mentioned more in the present day. The greatest overall increase in percentage points was in the following reasons: drug addicts, homeless and drunk people. Even so, there were considerable differences among the particular cities. A comparison of the relative frequency (i.e., how often

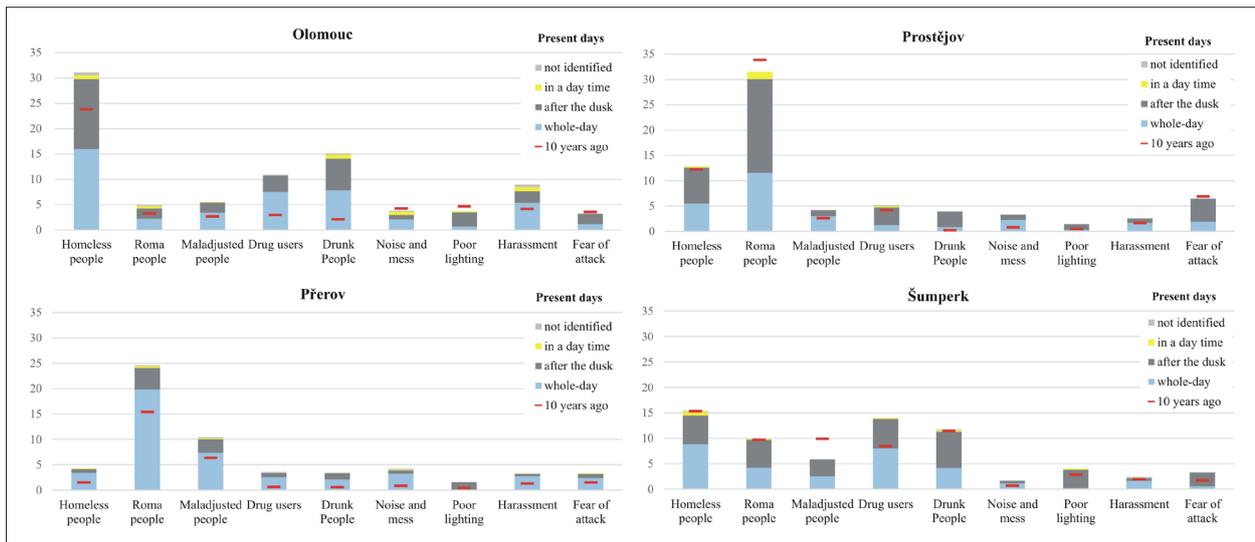


Fig. 4: The most common reasons for the outlines (the y axis represents the percentage of the outlines with the given reason with respect to the total number of outlines in the city). Sources: authors' survey and processing

a particular reason was mentioned compared to the others) also leads to some important findings. In comparison with the other reasons, homeless people and the Roma people were mentioned more 10 years ago, but drunk people and drug users are remembered presently instead.

Reasons for the perceived fear of crime also vary with respect to the time of day. Except for the highly specific case of Přerov, all other cities demonstrated two separate groups of respondents in most of the reasons: the first group felt fear throughout the whole day, while the other group only felt it at night (apart from the reasons connected to poor lighting, for example, which is a typical side-effect of the dark hours). As the results clearly show, the least amount of fear perceived by the respondents was in the places marked 'only during the day'. The only exception in this matter is the poor lighting in Šumperk, where the 'whole-day' option had a 0.01 smaller percentage point than the variant 'only during the day'. This variant was found in more than 1% of the outlines in Prostějov, with the reason given as the Roma people (Fig. 4). In all four cities the differences between the 'whole-day' and 'only during the night' reasons were mainly related to the noise and harassment (these reasons mostly occurred throughout the whole day), poor lighting (the reason mostly occurred, logically, at night) and the fear of being attacked (the reason also occurred at night except for the very specific case of Přerov, where this reason occurred more throughout the whole day). The fact that the respondents from Přerov experienced fear of crime more often throughout the whole day rather than just at night, reflects the strength of the meaning of the core area of fear in Přerov.

5. Conclusions

For the first and second research questions, based on the findings it is possible to confirm the changes as well as the stability of topophobia in the identified places in the context of fear of crime, both in the long-term time perspective and in everyday repeated experiences. As shown by the results, in the case of parks, a change in a place's topophobic meaning dependent on time (especially from a cyclical time perspective) can be observed. In contrast, when speaking about train stations and their surroundings, a stable negative meaning in linear time as well as in cyclical time can be observed. These stable or changing topophobic meanings did not emerge

from nowhere. Rather, they can be interpreted as part of the becoming of individual consciousness (Pred, 1984). This means the topophobic meanings of places are interwoven with the biographical formation and becoming of place. Our results also suggest the use of both the life path and the daily path of residents in order to attribute topophobia to specific places. Connecting the paths of two or more people fuels collectively shared topophobic meanings of places that are temporally specific, place by place. Regarding the third research question; in most cases the respondents determined that the reasons for fear were primarily particular social groups, such as homeless people, ethnic groups (the Roma) and those under the influence of alcohol and narcotics (drunk people and drug users).

In the final analysis, the results of our research suggest that in urban places the temporality of topophobic meanings, drawn from the experience of fear of crime, can vary considerably. The content of places means many things to different residents, and in general they are capable of interpreting, praising and evaluating the places in which they live (Amedeo, 1993), and temporality is applied here in an essential way. As such, these findings support the conceptualisation of place as a process, or in other words as a constantly becoming human entity (Pred, 1984). In this context, we can distinguish between four types of topophobic places that have been identified. First, the places with topophobic meaning that changes over linear as well as cyclical time. Second, the places with topophobic meaning that changes only over linear time. Third, the places whose topophobic meaning changes only over cyclical time. The first three types of place support the point made by Golledge and Stimson (1997, p. 393), who state that "perception or cognition of the place, its symbolism, its meaning, its cultural significance, and even its boundaries, may change". Fourth, we managed to explore and identify the places with a strong topophobic meaning that is stable in the long-term as well as over a single day. The residents similarly operated and interpreted the information sensed from these places and subsequently ascribed congruent meaning to the information, regardless of the time dimension.

The results suggest that both concepts of time can be employed in the fixation of topophobic meanings derived from the experience of fear of crime in four different ways.

In general, these conclusions imply the necessity for an individual approach to urban places, when policy makers attempt to understand specific places in their city. This is understood to be a crucial step before planning a new use for an area or using it for its original purpose and, more widely, for the process of urban planning. As Ceccato (2020c, p. 412) declares, urban planners and other municipality workers responsible for urban development would like to work more with safety issues in mind when planning. This effort can lead to a reduction in opportunities for crime and also to a reduction in or even an elimination of topophobic places.

This paper has particularly highlighted the stability and changes in topophobic meanings related to specific urban places, depending on the aspect of time. Simultaneously, it revealed other research problems whose examination could contribute to deeper knowledge. Follow-up research should elaborate on the influence of the socio-demographic characteristics of residents, regarding how intensively and why fear of crime is attributed to specific urban places. Similarly, the socio-demographic profile of the inhabitants should be considered in the research into the spatial and temporal dimensions of fear of crime.

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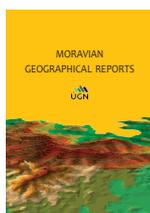
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When home becomes a cage: Daily activities, space-time constraints, isolation and the loneliness of older adults in urban environments

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Abstract

The geography of ageing is addressed in this article by providing new empirical evidence about the significant role of daily activities on the perceptions of isolation and loneliness. The developed model of socio-spatial isolation is based on data from time-space diaries and questionnaires completed by older adults living in three cities in the Czech Republic. The study suggests that socio-spatial isolation is a multicomponent (consisting of passivity, isolation and loneliness components), place-dependent and gendered issue. The passivity is significantly associated with the income and leisure sport activities. The isolation can be well predicted by the age, gender and education, and the frequency of work and specific leisure activities, which are constrained by health conditions, financial opportunities and spatial mobility. Particularly trips to nature, sport activities, cultural events, get together with friends, and visits to restaurants have a positive effect on reducing isolation. Women, particularly those who raised more children, more likely feel lonely in old age when family contacts are reduced. Visits to restaurants, shopping malls and cultural events have a positive effect on reducing loneliness. A constrained mobility and higher time consumption for necessary activities also proved to be an age-related and gendered problem. In this respect, policy interventions should seek to improve flexible work opportunities, the digital skills of older people, and the accessibility and safety of public transport with regard to perceived constraints, which is gaining in importance in the Covid-19 era.

Keywords: ageing; socio-spatial isolation; loneliness; daily activities; constraints; Czech Republic

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1. Introduction

“The secret of a good old age is simply an honorable pact with solitude” (Gabriel Garcia Marquez)

The current Covid-19 global pandemic is considered a historical moment with an unprecedented challenge concerning the impacts of the infection and related restrictions on the use of public space and social contacts, for everyone, but especially for older adults, their health and well-being (Wu, 2020). The current situation gives new contexts and significance to social science research on isolation and loneliness, which are major risk factors that have been linked with the poor physical and mental health status of older persons (Hwang et al., 2020). While the place of ‘home’ is usually associated with positive attributes such as privacy, freedom, family, safety, and protective boundaries,

many people experiencing social and spatial isolation (such as, for example, people with disabilities, mothers with infants, especially in suburban areas, or older people) may perceive home as more a cage than a castle (Yantzi and Rosenberg, 2008; Quinn, 2010).

The issues of social relations, loneliness and isolation in old age have been the subject of scientific research since at least the 1960s (see for example: Munnichs, 1964; Woodford-Williams, 1966). Even the most recent studies have emphasised, however, that we still have a very limited understanding of the meanings that older people ascribe to loneliness and social isolation, and how they live through and cope with these problems (Neves et al., 2019). The phenomenon has been studied by a number of disciplines, producing dozens of distinctive and sometimes conflicting

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definitions, and the attempts at operationalising and measuring it have followed similar paths (Gierveld and Tiburg, 2006; Cornwell and Waite, 2009; Zavaleta et al., 2014; Newall and Menec, 2019). The obvious conclusion is that older people experience loneliness and handle their life situations in highly individualised ways (Cohen-Mansfield and Eisner, 2020; Kirkevold et al., 2013). At least, there seems to be a partial consensus in that social isolation and loneliness are relational and multidimensional phenomena, which are associated with both structural (i.e. living settings, norms, resources) and agentic (individual actions and choices) dimensions (cf. Neves et al., 2019).

Although there is a large amount of literature (particularly geographical) on the everyday activities and spatial behaviour of older adults from one perspective (see Section 2), other views with respect to subjective perceptions of isolation and loneliness (especially in the field of social and clinical gerontology) are common, but the two approaches are rarely combined to the best of our knowledge (cf., for example: Vine et al., 2012; Vidovičová and Petrová Kafková, 2012; Siren et al., 2015). The present paper contributes to existing research by offering an interdisciplinary, geographical-sociological perspective on the problem by assessing the interrelationship between perceived isolation and loneliness and real time-space behaviour patterns. Moreover, unlike the majority of studies, which investigated isolation and loneliness by applying qualitative research methods, this research is based on the time-geographical approach using methods of time-space diaries, questionnaires and statistical analyses of quantitative data. Thus, this paper is concerned with four research questions:

- How do the spectrum and frequencies of everyday activities differ between various groups of older people?
- What space-time constraints are considered by older people as primary?
- What is the subjective perception of socio-spatial isolation by older people?
- How strongly do sociodemographic characteristics and everyday activities affect the perceptions of socio-spatial isolation?

We attempted to develop the concept of socio-spatial isolation in this respect (see Frantál and Klapka, 2020, concerning the socio-spatial isolation of mothers on parental leave), and apply it to older people. The remainder of the paper is organised as follows. The next section discusses the contributions of a time-geographic approach to the issues of ageing, isolation and loneliness. The next section is concerned with the empirical data and methods of analysis and processing. Results are presented and discussed in the following section, including comparison to some previous studies, if appropriate. The concluding section highlights the main findings and proposes certain recommendations for practice and future research.

2. Ageing, isolation and loneliness: a time geographic approach

The demographic situation in many developed countries presents problems related to population ageing, which are subject to research by many disciplines, including geography (see for example reviews by Warnes, 1981; Harper and Laws, 1995; Schwanen et al., 2012; Skinner et al., 2015). Varieties of scholarship exist within the geography of ageing, including health, caring, demographic and social aspects, and new theoretical and conceptual backgrounds have been

recently introduced into the field, such as the relational approach (Hopkins and Pain, 2007) and non-representational theory (Andrews and Grenier, 2015). A growing body of literature is concerned with ageing, everyday life and its rhythms and activity time-spaces, bringing to the fore intertwined issues of spatiality and temporality.

Theoretical concepts and the methodological apparatus of time geography have been applied, though in some cases not explicitly, to a number of various studies related to the issues of ageing, and the tradition is quite extensive. Only a selection, mostly of recent literature, follows. Much work was carried out in mobility studies. Hanson (1977) examined the travel activity patterns in households of older people in comparison to non-elderly households. The everyday mobility of an older suburban couple and its development over time was evaluated by Stjernborg et al. (2015). Van den Berg et al. (2011) studied the travel of older persons in relation to leisure time and social contacts. Nordbakke (2013) aimed her attention at the everyday travel activities and the needs of older women in an urban environment. Shoval et al. (2011) tracked the movements of cognitively impaired persons using GIS technology. Another avenue of mobility inquiry includes the concept of well-being (Nordbakke and Schwanen, 2014). Siren et al. (2015) studied the relationships between out-of-home mobility activities and well-being among persons with mobility impediments. Using a quantitative approach, Cuignet et al. (2020) discussed the concepts of potential and actual mobilities in relation to well-being in an urban space, including feelings of happiness.

Apart from the mobility-related research, other less frequent topics are discussed. For example, Fortuijn et al. (2006) explored the activity patterns of older adults in six European countries with respect to their contributions to local economies after their retirement. Some authors aim at environmental context and place. Thus, Vine et al. (2012) assessed urban design and amenity accessibility for older people. Antoninetti and Garrett (2012) analysed the interaction of older adults with their residential settings based on the concept of body capital. Lager et al. (2016), Lee (2014) and Paiva (2016) studied elders' experiences of place and rhythms in an urban space. In contrast to out-of-home activities, Leonardi et al. (2009) aim at the domestic environment. Hardill and Olphert (2012) and Muliček and Stachoň (2019) studied how older people deal with information and communication technologies.

Many of the above-mentioned studies hint at the notion of loneliness. In order to foster the social contacts of older people, travel (Van den Berg et al., 2011) and communication technologies (Hardill and Olphert, 2012) are means to do that. Increasing age stresses the importance of the domestic environment and different meanings are assigned to it by ageing people (Leonardi et al., 2009). Easily accessible amenities can also increase the level of social contacts and participation of older people in the social life of a neighbourhood (Vine et al., 2012; Lager et al., 2015). On the other hand, the need for car use results in loss of social contacts in a suburban space (Stjernborg et al., 2015).

Time geographic research builds on a number of concepts (Ellegård, 1999). We stress the concepts of paths and constraints, in particular, for the purposes of this paper. According to time geography, each individual has a time at her or his disposal, which is bounded to a specific spatial location; hence, time geography is concerned with the grasp, analysis and interpretation of the four-dimensional dynamics. The nature of such dynamics comprises subjective

decision processes, anchored in an objective framework (activity time-space). The existence of an individual faces a system of space-time constraints, which can basically be divided into two groups: objective constraints and subjective constraints. As for the former, time geographical literature speaks of capability, coupling and authority constraints (e.g. Lenntorp, 1999; Frantál et al., 2012). As for the latter subjective constraints, almost all objective constraints can be seen subjectively by every individual. Altogether the system of constraints obstructs or impedes an individual in the execution of activities, fulfilment of projects, reaching demands and needs.

The research on everyday activities and social isolation in time geography builds upon the use of time-space diaries and time-space questionnaires (e.g. Gershuny and Sullivan, 1998; Vilhelmson, 1999; Timmermans et al., 2002; Horner et al., 2012), whose keeping, processing and visualisation remains a challenging task for researchers. Recently there is a growing role of geographical information systems (GIS), which help us to analyse the records in diaries and questionnaires (see for example: Kwan, 2004; Kwan and Lee, 2004; Lee and Kwan, 2011). Time space diaries have two compulsory items – time and space, and there are several possibilities for optional items concerned, for instance, with the emotive load of stations and paths (McQuoid and Dijst, 2012), and with ICT context (Schwanen and Kwan, 2008), to name two, which can be seen as the most original. A more detailed description of the methodology used in this study follows.

3. Methods and data

The Czech Republic is a Central European country with slightly more than 10,600,000 inhabitants (2020 estimates), where nearly three quarters of the population live in urban areas. The trend in ageing of the Czech population can be clearly seen in the population statistics. This is reflected in an increase in the proportion of people aged 65 and over (currently nearly 20%, which is almost five percent more than ten years ago), an increasing median age of the population (42.1 years), and the values of indicators such as the old age dependency ratio (29.6) and total age dependency ratio (53.8) (Eurostat, 2019). Life expectancy in the Czech Republic currently exceeds 78 years (76 for men/82 for women), which is slightly higher than most post-socialist countries but lower than most of Western and Southern Europe (World Bank, 2019). The retirement age in the Czech Republic depends on the year of birth and (for women) also on the number of raised children. The current retirement age for a person who entered the labour force at age 22 is about 63 years. The retirement age is gradually

increasing, however, by two months per birth cohort until reaching age 65 (which was set by the Czech government as an upper age limit for retirement for people born in 1965 and later) (cf. OECD, 2020).

The survey of older adults presented here was part of a wider project studying the time-space behaviours of specific population groups, such as students, mothers on parental leave, disabled persons and older adults living in large Czech cities (see Frantál et al., 2012; Frantál and Klapka, 2020). The sample included 100 older adults living in the cities of Brno (N = 32), Olomouc (N = 35) and Ostrava (N = 33) (see Fig. 1).

The questionnaires were distributed by students of geography at the cooperating universities, to their grandparents living in the studied cities. The authors are aware that with respect to the focus of research on large cities and the sampling method (resulting for example in a higher representation of people with university education), the results do not provide a representative profile of the Czech older population. Our survey also did not include seniors living in retirement homes and similar social facilities, which represent almost one tenth of the older population in the country. Nevertheless, the objective of the study was not to generalise results to the entire population but to explore specific relationships, particularly differences in the perception of social-spatial isolation with respect to socio-demographic characteristics and daily activities. The basic characteristics of the sample are found in Table 1. The sub-samples of respondents for individual cities did not differ significantly with regard to age, gender, number of children or the proportion of economically active people. In the city of Brno, however, there was a higher proportion of respondents with a university education, who reported slightly more working hours as well as higher household incomes. These differences, however, did not affect the results regarding the daily activities or the perceptions of socio-spatial isolation (as will be shown below).

We explored (using space time diaries and questionnaires) the daily activities of older people and their perceptions concerning isolation and loneliness over three days (Monday, Wednesday and Saturday) in the first week of October. Early October was chosen to avoid the more extreme weather conditions that can negatively affect the mobility of older people (and their ability and willingness to take part in out-of-home activities) during the summer and/or the winter periods (see for example: Böcker et al., 2017). The questionnaire consisted of three sections. The first included an assessment of the frequency of at-home leisure activities and their duration during a day, and the frequency of activities occurring out-of-home, including part-time work. The second section aimed at the subjective perceptions of space-time constraints of daily activities and perceptions of socio-spatial isolation, which was measured using a newly-developed (by the authors) scale consisting of 9 statements (see Tab. 5, items 1–9), with a 5-point Likert response format. The first 9 items (if aggregated as an additive scale) showed a coefficient of reliability (Cronbach's $\alpha = 0.685$), which can be considered as acceptable or satisfactory (see Taber, 2018).

The statements were defined considering previous studies and scales measuring isolation and loneliness among older adults: specifically, the 'social disconnectedness scale' and the 'perceived isolation scale' (Cornwell and Waite, 2009), 'scales for emotional and social loneliness' (Gierveld and Van Tilburg, 2010), and the 'UCLA loneliness scales'



Fig. 1: Case study areas

Indicator	Category	Share [%]		
		Males	Females	Total
		(N = 34)	(N = 66)	(N = 100)
Age (years)	less than 65	12	24	21
	65–69	40	38	39
	70–74	24	12	15
	75–79	6	14	12
	80 and more	18	12	13
Education	Basic or secondary without GCE	18	21	20
	Secondary with GCE	49	46	47
	Tertiary	33	33	33
Number of children	0	0	8	5
	1	19	22	21
	2	69	49	56
	3 or more	12	21	18
Household income (CZK)	less than 20,000	42	57	52
	20,000–29,000	39	27	31
	30,000–39,000	15	12	13
	40,000 and more	4	4	4
Living alone	yes	3	15	11
	no	97	85	89
Work during retirement	yes	36	30	32
	no	64	70	68

Tab. 1: Basic characteristics of the survey sample

Source: authors' survey

(Russell, 1996; Penning et al., 2014). Besides that, we have included statements related to the concept of active ageing (Rantanen et al., 2019). Another item (10) was added asking about attitudes to work during a retirement. The third part included socio-demographic characteristics.

The data were digitalised and analysed using SPSS software v.24, applying descriptive statistics, the Analysis of Variance (ANOVA) for different groups, Principal Components Analysis (PCA) for identifying specific components of socio-spatial isolation, a bivariate cross-correlation analysis of independent variables against values of extracted components (statistical significance was tested using Pearson's r correlation coefficient, and examining the p -value for each pair of variables), and finally the linear regression modelling for determining relationships between selected leisure time activities and sociodemographic indicators as independent (explanatory) variables and the components of socio-spatial isolation as dependent variables.

4. Results and discussion

The analysis and presentation of results is divided into four sections, following the research questions. First, the relative frequencies of work and leisure at-home and out-of-home activities of people are investigated. Second, the space-time constraints are explored and their relationship to specific daily activities and groups of older people are analysed. Third, subjective perceptions and attitudes of older people are explored, and specific components of social-spatial isolation are identified. Fourth, the relationships between sociodemographic characteristics and daily activity patterns

(as independent variables) and social-spatial isolation and its partial components (as dependent variables) are analysed and discussed.

4.1 Daily activity patterns

About one third (32%) of older people from our sample still work at least part-time. For this group, 44% worked less than 40 hours a month, 28% between 40 and 80 hours, and 28% more than 80 hours a month (5 people worked full-time). Working activity significantly negatively correlates with age ($r = -0.379$, $p < 0.01$). Two thirds of seniors under the age of 65 reported working, almost one third in the age group 65–69 years, but only one tenth among those older than 70 years. The proportions of working seniors in our sample are higher than those shown by national surveys (Czech Statistical Office, 2019), however, which is probably because our surveys were carried out in large cities, where there are more opportunities to obtain a job than in rural areas, and due to a relatively younger and more educated sample compared to general elderly population. Overall, nearly 10% of people aged 65 to 74 in the Czech Republic are economically active, which is about the EU-28 average (Eurostat, 2019). The share of economically active Czech older people is higher than in most South-European countries, but it is lower than in Scandinavian and Baltic countries or the UK (*ibid.*).

The frequencies of selected at-home and out-of-home leisure activities are presented in Figures 2 and 3. Figure 2 shows the average duration (estimated by the respondents themselves) of specific leisure activities during their typical day. The time spent watching TV represents the biggest part of older peoples' days (except for sleep time), on average

exceeding three hours. On average, older people spend slightly less than two hours per day in active rest (walks, exercises and the like), and reading books and magazines. Less than one hour per day is spent on the Internet and by calls with relatives and friends. As concerns the out-of-home activities, the most frequently performed activities (as reported by the respondents) are walks around the residence and shopping in the neighbourhood, which people do several times a week. Visits to the city centres, meeting friends and trips to nature are realised usually several times a month. The visits to shopping malls, restaurants and cultural events are realised on average just once a month or even less frequently.

There are very large variances between the frequencies of activities realised by different groups of seniors, however. In order to perform a deeper analysis of these differences,

we calculated the overall activity index (as the sum of the frequencies of all leisure time activities). The overall activity index could theoretically vary between 0 (minimum) to 60 (maximum). The mean value was 25.2 and median value 25.0. Three categories of activity rate (involving roughly the same number of respondents) were created for the purposes of subsequent analyses: low (less than 20), medium (20–29), and high (30 and more). Table 2 presents differences in the proportion of respondents in these categories in sub-sets of the sample.

We found significant differences in the level of activity according to age, work activity and income (Tab. 2). On the other hand, there are not significant differences in the frequency of activities according to gender and education (not included in the Table). The only specific activity that is significantly affected by education is the use of the Internet,

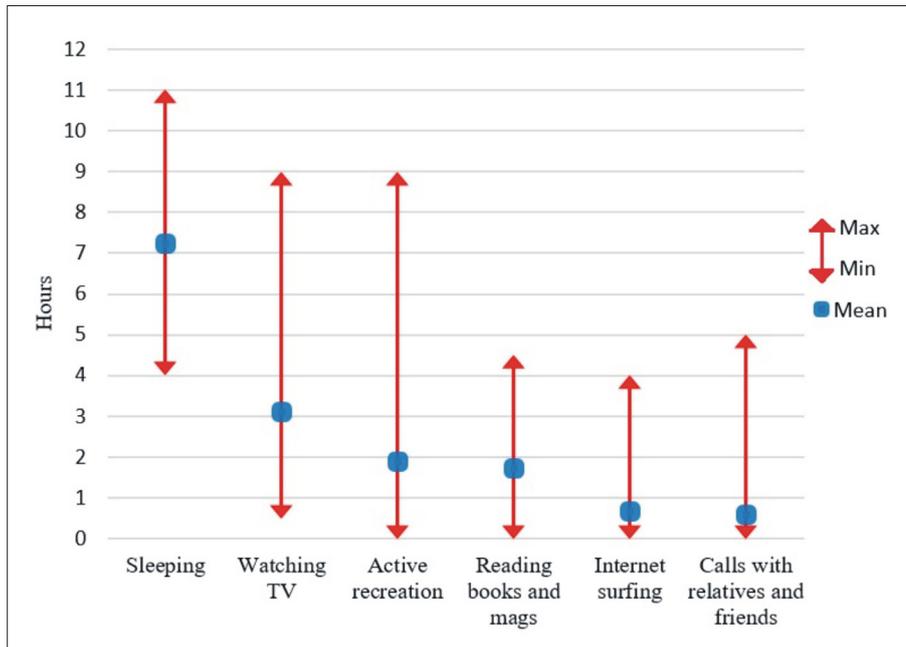


Fig. 2: Average daily duration of selected leisure activities. Source: authors' survey

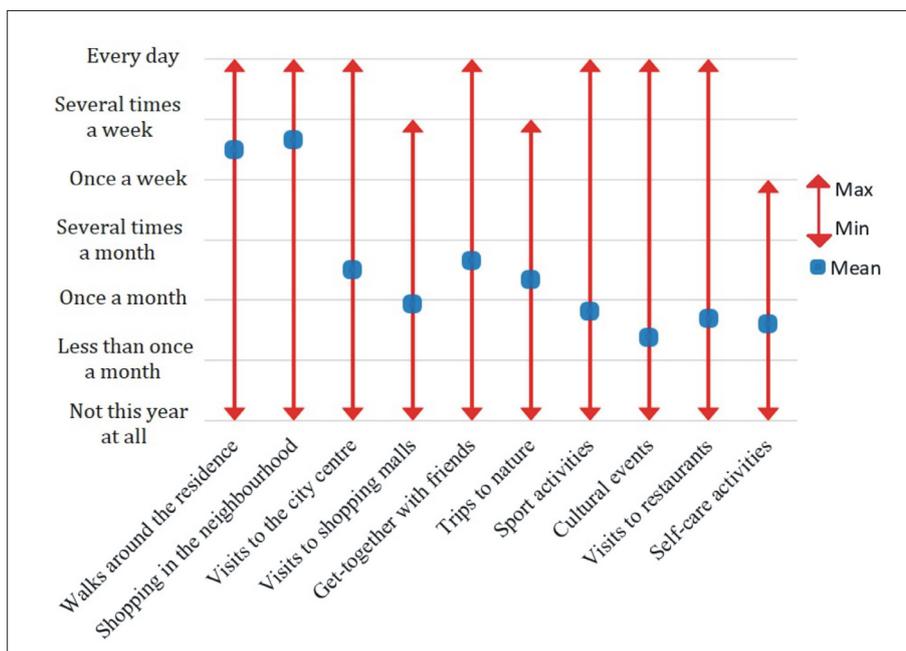


Fig. 3: Frequency of selected out-of-home activities. Source: authors' survey

Category		Activity Index			Kendall's tau-b ¹	ANOVA ²		
		Low (< 20)	Medium (20–29)	High (30+)		Mean	F	Eta
Age	Less than 65 years	22%	56%	22%	– 0.205*	25.2	3.584	0.365**
	65–69 years	13%	45%	43%		27.4		
	70–74 years	31%	44%	25%		25.4		
	75–79 years	37%	37%	26%		24.2		
	80 and more years	54%	46%	0%		20.0		
Work	Less than 40 hours	7%	64%	29%	– 0.220*	27.9	2.878	0.407*
	40–80 hours	11%	22%	67%		28.4		
	more than 80 hours	33%	67%	0%		23.3		
Household income (CZK)	Less than 20,000	27%	35%	39%	– 0.179*	25.5	1.353	0.201
	20,000–29,000	26%	48%	26%		25.3		
	30,000–39,000	8%	92%	0%		25.6		
	40,000 and more	100%	0%	0%		18.8		

Tab. 2: Differences in the levels of activity of older people

Notes: ¹The values of nonparametric correlations between categories of Activity Index and categories of age, work and household income. ²The result of the Analysis of Variance (ANOVA): mean values of the Activity Index for each group of seniors, F-test and Eta coefficients. The correlations/effects are statistically significant at *0.05 level.

Source: authors' survey

and the only specific activity that is significantly affected by gender is self-care (specifically visits to hairdressers and cosmetics, which are much more frequent for female respondents). The highest level of activity is shown by people aged 65–69, and with increasing age the frequency of activities decreases continuously. The level of activities is negatively correlated with working hours, which increase household income but probably reduce the amount of leisure time. This is also the reason why seniors under the age of 65, who have the highest working hours and thus have higher incomes, show a lower rate of leisure activities than seniors aged 65–69. The only specific activity that is significantly affected by education is the use of the Internet, and the only specific activity that is significantly affected by gender is self-care (specifically visits to hairdressers and cosmetics, which are much more usual for women). The only daily activity that showed significant differences in its frequency between the studied cities is the use of the Internet and social networks. Specifically, older people in Brno spend twice as much time (75 minutes per day) on the Internet as people in Ostrava (28 minutes per day) and Olomouc (32 minutes per day), which is probably due to a higher proportion of people with a university degree in the Brno sub-sample.

The differences in the level of activity according to age can be well illustrated also by the comparison of the measures of spatial mobility, particularly the number of paths made and stations visited per day, and the average distances travelled

per trips and per day (see Fig. 4 and Tab. 3). With increasing age, the number of stations visited during the day and the total distance travelled per day decrease significantly.

4.2 Space-time constraints

The daily activities of people are affected by many constraints. In total, both health conditions and financial opportunities were mentioned as fundamental constraints by nearly 60% of older persons. Family commitments and transport mobility are principal constraints for 25% and 22% respectively of older people in total. These results are in line with previous studies (see for example: Baltes et al., 1990; Izumiyama et al., 2007; Paiva, 2013). Among other specific constraints that limit the time that Czech older people spent for leisure activities were the weather conditions, the need to work in the garden and care for pet dogs. The importance of the last two-mentioned constraints can be considered above average in the context of Europe, as the Czechs are regarded as a nation of gardeners and breeders of dogs and cats (see e.g. FEDIAF, 2017). We can assume that working activities and leisure-time activities in particular are influenced by numerous other factors that are related more to the lifestyle of the individual, and by extension to the individual's cultural and social capital (cf. Vidovičová and Petrová Kafková, 2012).

The relative importance of specific constraints affecting the participation of older persons in daily activities, as perceived by different age categories, is presented in

Measures/Age category	Less than 65	65–79 years	80 and more
Number of paths made per individual per day	3.33	3.00	1.60
Number of stations visited per individual per day	3.75	3.05	2.25
Average distance travelled per individual per path (km)	7.05	5.13	5.26
Average distance travelled per individual per day (km)	23.50	15.40	8.40

Tab. 3: Selected measures of daily mobility of older people in Brno city

Source: authors' survey

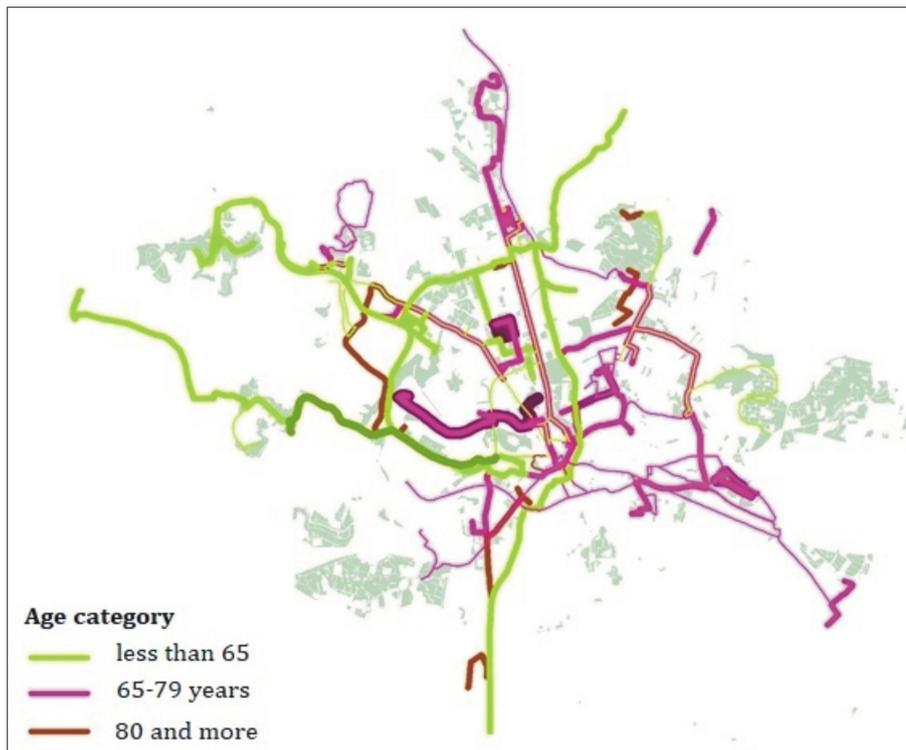


Fig. 4. Visualisation of paths of older people living in city of Brno per one weekday in October
Source: authors' survey

Figure 5. It is evident that the effect of health conditions and transport mobility increases with age, while the importance of family commitments (e.g. care for grandchildren or other family members) and work duties declines with age. The role of financial opportunities increases with age up to 74 years, but then it declines significantly for people over 75 years.

Older people who consider health conditions a primary constraint for their activities (given their age) reported more frequent reading books and magazines at home and shopping in the neighborhoods, while they showed lower frequencies of meeting friends at out-of-home places and they also reported significantly less work activities (see Tab. 4). Financial constraints significantly affect the frequency of using the Internet and engaging social networks as well as the frequency of visiting sport activities. In the city of

Olomouc, there is a significantly smaller proportion of older persons who perceive work duties as an essential constraint for their leisure activities, which is due to a significantly smaller frequency of people with a university degree in the group (also with fewer working hours). The people who work more (younger and more educated people) spend less time on watching TV and shopping in the neighborhood, while they devote more time to sport activities.

The family commitments are positively correlated with the number of children and negatively with age. The people who consider family commitments as principal constraints, however, more often get together with friends and visit shopping malls. Transport mobility significantly affects the frequency of visits to cultural events, shopping malls and restaurants, but also walks around the residence. Transport

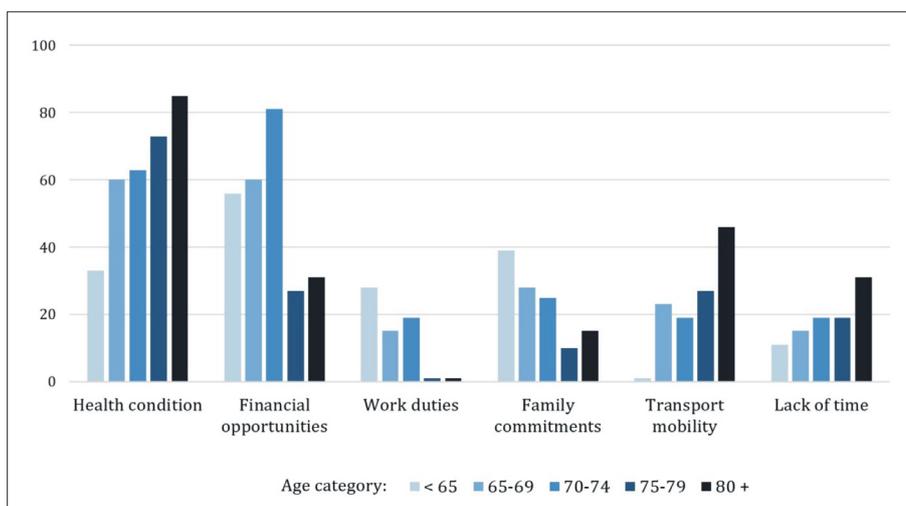


Fig. 5: The relative importance of specific space-time constraints
Note: Columns show percentage of respondents who consider the constraint primary for her/his daily activities
Source: authors' survey

Predictors/Constraints	Health conditions	Financial opportunities	Work duties	Family commitments	Transport mobility	Lack of time
Age	+		-	-	+	+
Gender (Female)					+	+
Education			+			
Place of residence			+			
Living alone						
Number of children				+		
Household income		-	+			+
Work activity	-		+	+		+
Active rest (walks, exercises)						
Reading books and mags	+					
Internet & social networks		-			-	
Watching TV			-	-	+	
Walks around the residence					-	
Trips to nature						
Sport activities		-	+			
Cultural events					-	
Get together with friends	-			+		
Visits to restaurants					-	
Shopping in the neighbourhood	+		-			
Visits to shopping malls				+	-	
<i>Legend:</i>						
		Correlation significant at 0.01 level				
		Correlation significant at 0.05 level				
	+/-	Positive/Negative correlation				
		Statistically non-significant correlation				

Tab. 4: Correlations between perceived constraints, socio-demographic characteristics and specific daily activities
Source: authors' survey

mobility is a primary constraint more likely for older persons and females. This result supports the theory that mobility is a highly gendered problem and space-time constraints operate differently in the everyday lives of men and women (see for example: Schwanen et al., 2008). The previous studies pointed out that female mobility is characterised by some specifics, such as trip-chaining, time poverty, less frequent use of the car, a lower number of stations visited per day and the uneven distribution of time among them (see: Nordbakke, 2013; Peters, 2013; Gauvin et al., 2020).

It may seem surprising that the older a person is, the greater the lack of time she/he perceives, even though being much less active as concerns the spectrum and frequency of activities (see Tab. 2). This perception of a lack of time, however, can be explained by the fact that older people often have physical difficulties, limited options for mobility, and lack of family support, which limit the time for leisure activities by increasing the time spent on daily mandatory activities (self-care, cooking, etc.) and travelling, and limits access to urban space and some activities to determined temporal periods (cf. Ohmori et al., 1999; Paiva, 2013). Paiva (2013, p. 7) speaks in this context about the “temporal convergence of activities”.

The level of activity or passivity of older people is also influenced by economic status. The effects of financial resources as a constraint on the participation in leisure

activities, however, loses its relevance for people older than 75 (and particularly for those older 80 years), when the relative role of health and mobility becomes essential. The other constraints that can significantly limit the participation of older people in leisure activities (as reported by existing literature) are perceptions of inhospitality or insecurity related to some urban spaces – areas of cities (Paiva, 2013), ways of travel (Sundling, 2015), and/or time periods during a day (e.g. fears of going out in the evening, which limits the possibility of leisure time activities, see also the paper by Šimáček et al. in this Special Issue).

4.3 Perceptions of socio-spatial isolation

Table 5 presents the distribution of responses for each scale item represented by statements about the perceptions of social isolation, loneliness, availability of time and activity. Almost one third of older respondents admit that they spend almost all their time at home since they retired, and slightly less than one third of respondents has often feelings of loneliness (specifically 12% strongly agree and 15% agree on ‘having often feelings of loneliness’). These numbers are hardly comparable with existing studies from other countries due to different methodologies and the measurement tools used. While some authors report up to 15% of older adults feeling often lonely (see for example: Pinqart and Sorensen, 2001; Tomstad et al., 2017), other studies report 20 to 40 percent feeling lonely (see the literature review in

Statement / Response [%]	Strongly agree (1)	Agree (2)	Neither (3)	Disagree (4)	Strongly disagree (5)	Mean	Std. Deviation	Variance
1) I spend almost all my time at home since I retired	10	21	16	18	35	3.47	1.41	1.99
2) I am actively involved in news from former work and work specialisation	42	27	8	15	7	2.17	1.31	1.74
3) I can spend a lot of time meeting my friends and acquaintances	37	33	16	9	5	2.13	1.16	1.34
4) I can spend a lot of time learning and increasing my professional skills	22	39	23	9	7	2.40	1.14	1.30
5) In retirement, I can focus more on my hobbies that I couldn't do before	23	41	17	12	7	2.39	1.17	1.37
6) I can make me happy by buying something nice for myself	39	30	15	12	4	2.12	1.17	1.38
7) I can talk and share my troubles and joys with my partner and family	42	27	19	9	3	2.05	1.12	1.25
8) Our children have their own worries and do not have much time to visit us	5	28	14	32	21	3.35	1.23	1.52
9) I have often feelings of loneliness since I retired	12	15	20	25	28	3.42	1.36	1.80
10) When retirees work, they cannot enjoy retirement so well	11	16	18	34	21	3.38	1.29	1.65

Tab. 5: Descriptive statistics of older people's attitudes
Source: authors' survey

Luo et al., 2012, p. 907). The aim of this study, however, was not to present absolute numbers but to explore specific relationships, particularly differences in perceptions with respect to socio-demographic characteristics and daily activities, which will be discussed in more detail in the following section.

In order to explore the structure of relations among specific statements and to find out if they can be divided into groups representing specific aspects (components) of social-spatial isolation, we applied a Principal Components Analysis (PCA). The results of PCA are presented in Table 6, and they were generated using the Varimax rotation solution with measures of the Kaiser-Meyer-Olkin test of sampling adequacy ($KMO = 0.620$) and Bartlett's test of sphericity ($p < 0.001$) confirming the relative appropriateness of the selected variables for the PCA. The first two components were much stronger (their Eigenvalues were 2.43 and 1.61) than the remaining one component, and account for 45% of the variability of item responses from the sample. The total variance explained by three extracted components is then nearly 61%.

The extracted components represent new variables, aggregate indices expressing weighted (according to the observed factor loadings of individual items) additive scores of the rate of agreement or disagreement of respondents with the original inter-related statements. In relation to their semantic meaning, we chose the following labels: (1) Passivity; (2) Isolation; and (3) Loneliness. Then we worked with these new variables, trying to identify differences in the perceptions of older people according to their sociodemographic characteristics and the share of time and frequency of daily home and out-of-home activities.

4.4 Relationships between daily activity patterns and socio-spatial isolation

We used a correlational analysis to examine the relationships between the component and the sociodemographic characteristics and daily activities of older people (see Tab. 7). Isolation is perceived more likely by people in older age groups (who spend most of their time at home and have less activities and social contacts), while loneliness is reported more likely by females. This is in line

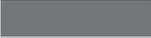
Statement	Components		
	Passivity	Isolation	Loneliness
I can spend a lot of time meeting my friends and acquaintances	0.841		
I can spend a lot of time learning and increasing my professional skills	0.800		
In retirement, I can focus more on my hobbies that I couldn't do before	0.589		
I spend almost all my time at home since I retired		0.746	
Our children have their own worries and do not have much time to visit us		0.659	
I am actively involved in news from former work and work specialisation	0.415	– 0.648	
I can make me happy by buying something nice for myself			0.727
I can talk and share my troubles and joys with my partner and family		0.344	0.699
I have often feelings of loneliness since I retired			– 0.683

Tab. 6: Principal components analysis of older people's attitudes

Notes: Varimax rotation solution; $KMO = 0.620$; $p < 0.001$. Only factor loadings over 0.3 are presented in this Table.
Source: authors' survey

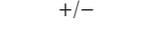
Predictors/Factors	Passivity	Isolation	Loneliness
Age		+	
Gender (Female)		+	+
Education		-	
Living alone			
Number of children			+
Household income	-	-	
Work activity		-	
Active rest (walks, exercises)	-		
Reading books and mags			
Internet & social networks	-	-	
Watching TV		+	
Walks around the residence	-		
Trips to the nature		-	-
Sport activities	-	-	
Cultural events	-		-
Get together with friends	-	-	
Visits to restaurants	-	-	-
Shopping in the neighborhood		+	
Visits to shopping malls			-

Legend:

 Correlation significant at 0.01 level

 Correlation significant at 0.05 level

+/- Positive / Negative correlation

 Statistically inconclusive correlation

Tab. 7: Correlations between sociodemographic characteristics, daily activities and socio-spatial isolation
Source: authors' survey

with existing knowledge (see for example: Pinquart and Sorensen, 2001; Perissinotto et al., 2012). It is interesting that we have also found a positive correlation between loneliness and the number of children. It can be hypothesised that people with more children, who were used to living in a large family, are more likely to suffer from the separation from children and lonely life in old age. While work activity and income negatively correlate with passivity and isolation, they have no effect on the perception of loneliness. More educated people are less likely to feel isolated.

Surprisingly, we found no relationships between whether a person lives alone or with a partner and the subjective perceptions of passivity, isolation and loneliness. This finding is in contradiction to most other studies, which reported living alone among the key determinants of loneliness (Cornwell and Waite, 2009; Tomstad et al., 2017; Igarashi, 2019). No significant differences in the perceptions (of space-time constraints and socio-spatial isolation) between three studied cities have been detected, which indicates a relatively similar quality of life of older people in the regional cities in this study.

There are positive effects of the frequency of some leisure activities on the reduction of isolation and loneliness, particularly, trips to nature, sport activities, visits to cultural events, visits to restaurants and meeting friends. Also, work activity, which significantly affects the economic status of people, has a positive effect on increasing daily activities and decreasing isolation. These results confirm existing hypotheses that older people who are more active in everyday life activities or activities such as employment, are generally

happier and are more positive in current assessments of their lives (cf., Vidovičová and Petrová Kafková, 2012). The time spent on the Internet and social networks also has a positive effect on decreasing the level of isolation. In this respect, one issue is that many Czech seniors still have a lower level of digital literacy and relatively worse access to high-speed Internet (also due to financial opportunities) than their peers in Western and Northern European countries (Eurostat, 2020).

The time spent watching TV and shopping in the neighbourhood are associated with the perception of isolation. On the other hand, the frequency of visits to shopping malls and/or supermarkets in the city centres, have a positive effect on reducing the perception of loneliness. This difference well illustrates the significant role of 'place' in the realisation of a specific activity (e.g. shopping) in the perception of isolation. For socially isolated people, visits to supermarkets and shopping malls not only serve meeting basic needs (such as the purchase of food), but they constitute forms of recreational activities, entertainment, medical movement, strengthening social contacts, and a change in environment and 'escape from the stereotype' (cf. Vidovičová and Petrová Kafková, 2012; Křižan et al., 2018; Frantál and Klapka, 2020).

It is, however, more complicated to visit the shopping malls (most of which are located on the outskirts of the cities in this study) or other services and/or sport or cultural facilities for older people, who have limited transport mobility (no access to a car) and thus they have to spend more time travelling by public transport.

4.5 General linear model relationships

In order to provide a more general overview of these phenomena for older persons, we estimate a linear model accounting of the relations between the three components of socio-spatial isolation (from Tab. 6: Passivity, Isolation and Loneliness) and the socio-demographic characteristics of sample respondents and their activities, i.e. accounting for the interdependencies between the independent variables (compared to the simple correlations used earlier in the exploratory work). The analytical design, then, is as follows.

Three independent models, using Passivity, Isolation and Loneliness as dependent variables (DVs) and the selected sociodemographic and activity variables as independent variables (IVs):

$$DVs = \alpha + \{\beta_i \text{ Sociodemographic IVs}\} + \{\beta_j \text{ Activity IVs}\} + \{\beta_k \text{ Interactions}\} + \varepsilon,$$

where

- Sociodemographic IVs = gender; education; income (categorical); age (covariate);
- Activity IVs = trips to the nature; sport activities; cultural events; get together with friends; visits to restaurants; shopping in the neighbourhood (covariates);
- Interaction terms are limited to the sociodemographic IVs (e.g. gender*income); and
- $\beta_1 \dots \beta_k$ are the regression coefficients associated with terms in the models.

Estimation of these three models (using the General Linear Model procedure in SPSS v.27) proceeds as follows: at stage 1 all variables are entered into the equation and from the estimated model, the IV with the lowest level of significance ($\alpha = 0.05$) is then excluded from the model specification and the model is re-estimated. At stage 2, this is repeated and another IV is then excluded on the same basis ... until the model is stable with respect to significant IVs. For this analysis, the sociodemographic variables are included at all stages regardless of their significance levels (especially when they are reported in interaction terms). Finally, we note that the set of activity variables is a sub-set of all such variables, chosen partly on the basis of the simple correlations between activities and sociodemographic variables (Tab. 7), but also in this instance to retain the power of the model because of the limited sample size. The results of these analyses are interesting because of their independent nature (the DVs are independent of each other) such that interpretations of the model results are incremental and additive.

4.5.1 Model 1: Passivity

The final estimated model for Passivity is presented in Table 8. The omnibus model for Passivity ($p = 0.0001$) is very significant, with a R^2 of 0.343, indicating that slightly more than one-third of the variations in Passivity can be accounted for by the covariations and interactions between the IVs in this model. It is important to keep in

Source	Regression coefficient	df	Mean Square	F	Sig.
Corrected Model	–	12	2.634	3.479	.000
Intercept	– 0.45	1	1.385	1.829	.180
Age (covariate)	0.02	1	2.252	2.975	.088
Sport activities	– 0.18	1	9.274	12.248	.001
Gender (categories)	0.24 ¹	1	1.797	2.373	.127
Income (categories)	Main effect	2	3.181	4.201	.018
	Low vs. High Income ²	1			.002
	Medium vs. High Income ²	1			.036
Education (categories)	Main effect	2	1.861	2.458	.092
	Basic vs. Tertiary Education ³	1			.211
	Secondary vs. Tertiary Education ³	1			.004
Gender * Education	{see text}	2	1.697	2.242	.113
Income * Education	{see text}	3	4.145	5.474	.002

R Squared = 0.343

¹ baseline category is Female; ² baseline category is High income (> 30,000.00); ³ baseline category is Tertiary educational level

Tab. 8: Dependent Variable: Passivity
Source: authors' computations

mind that the effects of any one variable are estimated in holding constant the effects of all the other IVs in the final model. Interestingly, the principal effect in the model is Sport activities, which might be expected since the higher the levels of sport activities the lower the levels of Passivity (negative coefficient: -0.18 , $p = 0.001$). From the point of view of the sociodemographic variables, income has a strong effect ($p = 0.018$), largely driven by the higher income respondents (less passive), as well as the interaction between education and income ($p = 0.002$) as both more highly educated and higher income respondents reported

lower levels of Passivity. The gender effects point to higher levels of Passivity for females, and this is also important for the interaction between Gender and Education.

4.5.2 Model 2: Isolation

The final model for Isolation is presented as Table 9. The model for Isolation has a higher level of explanatory power than Model 1, with an R^2 of 0.521 ($p = 0.0001$), and with many more activities included in the final estimates. But the model appears to be driven primarily by gender ($p = 0.002$), as the negative regression coefficient indicates that females

Source	Regression coefficient	df	Mean Square	F	Sig.
Corrected Model	–	12	3.910	7.246	.000
Intercept	2.07	1	0.918	1.700	.040
Age	– 0.02	1	1.389	2.575	.113
Trips to nature	0.13	1	3.034	5.622	.020
Sport activities	0.12	1	4.194	7.772	.007
Get together with friends	0.13	1	2.244	4.158	.045
Shopping in the neighbourhood	– 0.19	1	3.122	5.785	.018
Gender (categories)	– 0.80 ¹	1	5.606	10.389	.002
Income (categories)	Main effect	2	0.809	1.500	.229
	Low vs. High Income ²	1			.200
	Medium vs. High Income ²	1			.860
Education (categories)	Main effect	2	2.010	3.724	.028
	Basic vs. Tertiary Education ³	1			.790
	Secondary vs. Tertiary Education ³	1			.000
Gender * Education	{see text}	2	1.725	3.196	.046

R Squared = 0.521

¹ baseline category is Female; ² baseline category is High income (> 30,000.00); ³ baseline category is Tertiary educational level

Tab. 9: Dependent Variable: Isolation

Source: authors' computations

are more isolated than males (in the context of accounting for the constant effects of all other variables in the model). Add the significant effect of education ($p = 0.028$) and the interaction between gender and education ($p = 0.046$) and the importance of these sociodemographic variables for Isolation is well established. In contrast, income does not appear to play an important role in accounting for variations in Isolation. As well, several of the activity variables are important in this model: Trips to nature, Sport activities, Get together with friends and Shopping in the neighbourhood. Compared to Model 1, then, Sport activities is joined by a number of other 'out-of-the-house' activities (positive regression coefficients, except for neighbourhood shopping) which reduce feelings of Isolation.

4.5.3 Model 3: Loneliness

The final model for discussion concerns Loneliness (see Tab. 10). This model is the least explanatory of those examined ($R^2 = 0.234$), while still significant ($p = 0.002$).

The main effect of Gender continues here ($p = 0.002$), indicating that females are more likely to express feeling of Loneliness than male respondents. Visits to restaurants also contributes significantly to this model ($p = 0.002$), but in a negative manner. The apparently weaker results from this model remind us that this is the third of the three Principal Component scores and hence has higher residual variance.

Overall, these three models point to some important aspects of the feelings of isolation and loneliness expressed by respondents in our sample. For Passivity, the income and education effects are primary, with an important contribution from sport activities. For Isolation, the gender effects are most important, as well as education and the interaction of gender and education. But added to this second model are several activity variables, including once again sports activities. The third model for Loneliness again highlights the importance of gender. Apart from some of the outdoor activities, the principal IVs affecting levels of the

Source	Regression coefficient	df	Mean Square	F	Sig.
Corrected Model	–	7	3.085	3.701	.002
Intercept	– 0.77	1	0.289	0.347	.558
Age	0.02	1	0.990	1.188	.279
Visits to restaurants	– 0.22	1	8.322	9.985	.002
Gender (categories)	0.66 ¹	1	8.297	9.956	.002
Income (categories)	Main effect	2	0.533	0.639	.530
Education (categories)	Main effect	2	1.696	2.035	.137

R Squared = 0.234

¹ baseline category is Female

Tab. 10: Dependent Variable: Isolation

Source: authors' computations

various indicators of loneliness are income, allied strongly with education, and gender. The latter factor appears to be most significant in this study: loneliness is gendered.

5. Conclusions and policy implications

The aim of this exploratory study was to provide new empirical evidence about the significant role of daily activities and ways of spending free time in older adults' objective behaviours and their subjective perceptions of socio-spatial isolation during their retirement. With respect to the issues raised in the introductory and theoretical sections, the current study contributes to the limited attention paid to the perception of daily activities in time-geographic research, including the design of time-use diaries. Such perceptions are also quantitatively assessed and compared to 'real' activities as recorded in time-use diaries. Our research further contributes to more general issue of quality of life in old age using the apparatus of time geography. From a methodological perspective, we tested a newly-constructed measurement scale consisting of nine items that can be used for measuring and analysing the subjective socio-spatial isolation of older adults. The Principal Components Analysis of data revealed that socio-spatial isolation consists of several components, specifically Passivity, Isolation and Loneliness, which are positively and negatively affected by different factors, the socioeconomic characteristics of people and their daily activities. The study results support the hypotheses that socio-spatial isolation is a multidimensional phenomenon and that isolation and loneliness are place-dependent and gendered issues.

This research project revealed that there is a considerable group of older people (about one third) living in Czech large cities who often feel being lonely and isolated, since they spend most of their time during retirement at home. Our empirical model supports the hypothesis that socio-spatial isolation is significantly affected by age and related health conditions, in particular, which affects the spectrum and frequency of participation in daily at-home and out-of-home activities. The activities which significantly help decreasing the perceptions of socio-spatial isolation include particularly trips to nature, sport activities, cultural events, get together with friends, and visits to restaurants. On the other hand, the frequency of watching TV and shopping in the neighbourhood are positively associated with isolation. Work activities, which significantly affect the economic status of people, have also a positive effect on reducing passivity and isolation of older people.

Almost one third of older people admit that their children and/or grandchildren have their own worries and do not have the time to associate with them. Our analysis detected that loneliness is more likely perceived by women than men, and by people who have more children. This suggests that people (particularly women) who lived in households with more children feel more loneliness in old age, when the frequency of personal contacts with children and grandchildren decline. Modern information and communication technologies, the Internet and social networks can play a very important role in this regard (particularly today in the Covid-19 era).

The participation of older people in daily activities is affected by many constraints, particularly health conditions, financial opportunities and transport mobility. The influence of health conditions and transport mobility as constraints increases almost linearly with age, while the importance of

economic status increases with age up to 74 years, but then its role significantly declines. Our data reveal that the older a person is, the greater the lack of time she/he perceives. This indicates that older people more likely have physical difficulties and limited options of mobility, which (together with lack of family support and other constraints) limit the time for leisure activities by increasing the time spent on daily mandatory activities and travelling. Transport mobility as an essential constraint of activities is more likely perceived by women, which confirms the theory that mobility is a highly gendered issue, as well as Isolation and Loneliness more generally (from the results of the general linear model).

What are the implications of this study for policy and practice? First, policy interventions should seek to improve the job offers and possibilities of flexible working, as well as motivational programs for older people to enable them to remain economically active, which would help both to raise their living standards and decrease their socio-spatial isolation. It is relevant in this respect that only about fourth of older people think that when retirees work (even part-time), they cannot enjoy retirement as well. Second, there is a need to focus on increasing older peoples' digital skills (including information literacy), which will allow a higher involvement of older people in Internet communication and social networks, but also the use of the Internet for education, work activities, shopping, et cetera, which have become significantly more important in the covid-19 era. Third, urban and transport planners should take better account of the specific needs of older people and improve the possibilities, accessibility and safety of public transport to places that are key stations and points of interest for the elderly.

Our analysis did not find any significant differences in the frequency of out-of-home work and leisure activities of older people living in the three investigated cities (Brno, Olomouc, Ostrava), nor in their perceptions of space-time constraints and socio-spatial isolation. It indicates a relatively similar level of the quality of life of older people in these three regional cities. It would be appropriate to focus future research on the comparison of cities of different order categories and spaces (urban, semi-urban, rural areas), using as representative population samples as possible. For example, a recent study by Lee (2020) reported that those who live in a rural area or village scored lowest on loneliness than people living in urban areas, which should be examined further. Further research should also turn its attention to other social groups, which are at risk of socio-spatial isolation and which are for the time being rather neglected by geographers, such as single mothers (and fathers), the long-term ill or disabled persons (Osman and Pospíšilová, 2019), for example.

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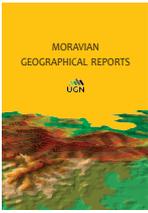
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The diffusion and development of time-geography in East Asia: The academic life paths of two key scholars

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Abstract

A summary of the diffusion and development of time-geography in East Asia, specifically in Japan and China, is presented in this article. Previous studies have provided reviews of time-geographic research and space-time behaviour research in both countries. Few studies, however, have told the story about how and why time-geography diffused into East Asia. By showing and analysing the academic life paths of Yoshio Arai and Yanwei Chai, we conclude that the development of time-geography in Japan and China goes hand in hand with their academic progress. Moreover, the interactions within their academic life paths mark some key events that promoted time-geography significantly. The similarities and differences between their academic life paths are also analysed in this article. Both scholars shared some common research topics, such as childcare problems, urban spatial structures and socioeconomic transformations, which were also the most prominent characteristics of time-geography in East Asia. In addition, the socioeconomic backgrounds of their academic life paths are also quite similar, which reflects the close relationship between time-geography and societal needs. Finally, this article discusses the effectiveness and disadvantages of the academic life path method, as the method has proven to be an important tool in analysing the role that key scholars play in promoting a certain discipline. In conclusion, the diffusion and development of time-geography in East Asia can hardly have happened without both individual scholars' hard work and the exchange and cooperation activities between scholars.

Key words: time-geography, life path, academic history, Chinese geography, Japanese geography

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1. Introduction

Time-geography was established by Hägerstrand (1970, 1982) and his colleagues in Sweden. It emphasises the physical existence and indivisibility of human beings and analyses the “choreography” of individual existence within space and time (Pred, 1977; Hägerstrand, 1975). The daily activity sequence is depicted as a path through space-time, and three major constraints, namely, capability constraints, coupling constraints and authority constraints, are analysed to understand the interactions between individual humans and society (Pred, 1973; Hägerstrand, 1970, 1982). Over the past 40 years, time-geography has been developed and applied in a variety of aspects, including urban planning, the evolution of regions and landscape, the diffusion of innovation, migration and urban growth, individual everyday life, travel behaviour and accessibility (Pred, 1977; Ellegård, 1999; Ellegård and Svedin, 2012; Kwan and Weber, 2003). Recently, time-geographers have paid attention to some lesser-known concepts such as ‘project’ and ‘pocket’ of local order (Ellegård

and Vilhelmson, 2004; Lenntorp, 2004). Some new research directions have been suggested, including domestic activity and energy consumption, information and communications technologies (ICTs) and their effects on everyday life, as well as segregation and health research from the perspective of individual activity (Ellegård and Palm, 2015; Thulin and Vilhelmson, 2012; Shaw and Yu, 2009; Kwan, 2013).

After its establishment in Sweden, time-geography has diffused throughout the world, including the United Kingdom, the United States, the Netherlands, Japan and China, and associated with local contexts and societies (Ellegård, 2018a). The development of time-geography in East Asia, especially in Japan and China, emphasised the application of a time-geographic approach to social issues, as well as urban planning. At the same time, the applications contributed to the innovation and extension of time-geography.

Several studies have reviewed processes of the introduction and diffusion of time-geography and the vast amount of time-geographic research in East Asia. For example, Okamoto and

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Arai (2018) give a detailed overview of how time-geography was introduced into Japan, adopted by geographers and used in urban life and societal problems. One of the most important works is an anthology containing several translated time-geographic classical articles, by Arai and other members in the Time-Geography Study Group (Arai et al., 1989). Moreover, several empirical studies about childcare problems from a time-geographic perspective have also helped to understand the burdens mothers with children face in urban life.

Chai (2013) first provided a review of space-time behaviour research in China, which is largely built on the theoretical framework of time-geography. Analytical methods and data collection techniques are the two main foci, and he pointed out three main research themes: understanding urban spatial structures from an individual activity perspective; understanding space-time behaviour in the transitional context; and implementing the space-time approach in transportation and planning practice. Some detailed information and other research topics regarding social equity and environmental sustainability were added in Chai et al. (2015). Lately, Chai et al. (2016) has provided an overview of behavioural geography research in China, including theoretical, empirical and applied research in behavioural analysis. Empirical research topics covered some continuing key themes, including socio-spatial reconstruction, relationships between urban forms and individual behaviours and spatial cognition. Some recent trends were also mentioned, including social equity, segregation, social change, social networks, activity-travel patterns, environmental pollution and health geography. In summary, time-geography and its related space-time behavioural approach in China are accepted and widely used by urban geographers, transportation researchers and urban planners to understand the interaction between urban space and individual activities.

We could conclude from the above review papers that Professor Yoshio Arai from the University of Tokyo and Professor Yanwei Chai from Peking University are the two key scholars, who have played an important role in introducing and developing time-geography in Japan and China, respectively. Arai formed a time-geography study group in 1987. The group members selected and translated influential studies made by renowned Swedish and American time geographers, including Torsen Hägerstrand, Allen Pred, Solveig Mårtensson, Bo Lenntorp and Kajsa Ellegård (Arai et al., 1989). They also conducted three activity diary surveys in Shimosuwa, Kawagoe and Nisshin, and published several empirical research papers about the daily activity of urban residents (Okamoto and Arai, 2018). Some of the group members continued to conduct time-geographic research after the group was cancelled (e.g. Arai, 2003; Okamoto, 2003). Chai, on the other hand, brought time-geography into China. Several introductory papers were published by him and by his research team (Chai and Wang, 1997; Chai et al., 2000; Chai, 1998; Liu and Chai, 2001). Several activity diary surveys were conducted in Dalian, Tianjin, Shenzhen, Beijing and Xining, and much space-time behaviour research was published by them. Chai also trained several leading urban geographers who dedicated themselves to time-geographic and related space-time behavioural research. Moreover, interactions and cooperation between these two scholars also helped to promote understanding daily activities in their own countries.

Only a few studies, however, have considered reviewing the contribution of these two scholars from the perspective of their academic experiences and interactions. The

developmental trajectory of time-geography in East Asia is also unclear. Pred (1977) pointed out that time-geography could also be applied to the intellectual history of a discipline or an academic school of thought by depicting and analysing the convergence and divergence of the life paths of key individuals, except for urban planning and some research themes in human geography. Similar to the daily path, the life path is a continuous line starting from the point of birth and ending at the point of death, depicting individual activities in time- and space-coordinates (Pred, 1973). On the other hand, unlike the daily path, the time scale of the life path is the whole life, and stations in the life path are usually the cities the individual has encountered. In this paper, we focus on academic activities. We use the concept of the academic life path to describe and analyse where, when and what academic activities scholars did from the time they entered college until now. Interactions between scholars were also analysed using bundles. The information on academic activities and interactions were mainly gathered by interviews with the scholars and their published articles. By summarising the diffusion and development of time-geography in East Asia from the perspective of the academic life paths of two key scholars, namely, Yoshio Arai and Yanwei Chai, this article aims to:

1. Demonstrate the effectiveness of the life path method in the study of academic history. Compared with other methods, the life path method can provide a clearer developmental trajectory of a certain discipline and highlight the importance of interactions between key individuals;
2. Provide a scheme for studying the diffusion and developmental history of a discipline. Many modern disciplines originated from Europe and diffused first into other Western countries, such as the United States, and second, into East Asia. Time-geography is one of these disciplines. In addition, the developmental process of time-geography is relatively easy to capture. Therefore, studying time-geography can provide a good example for other disciplines; and
3. Figure out how exactly time-geography diffused into East Asia, specifically Japan and China, and why time-geography developed differently in these two countries.

In the following section, we first provide an overview of the acceptance and evolution of time-geography in Japan from the perspective of the academic life path of Yoshio Arai. Next, a summary of the diffusion and development of time-geography in China is presented based on the academic life path of Yanwei Chai. We then focus on the interaction between these two scholars and highlight the important events that had a great influence on the development of time-geography in East Asia. Similarities and differences between their academic life paths are analysed in the next section. Meanwhile, it is also important to analyse the influence of social and economic contexts on academic life paths. Finally, we discuss and conclude the findings of this article with the strengths of the life path method.

2. Academic life path of Yoshio Arai and the acceptance and evolution of time-geography in Japan

Arai first formed a study group to systematically learn and introduce time-geography against a background of social-oriented transformation in Japan. He then conducted several activity diary surveys and some time-geography

research. After that, his cooperation with Chai diffused time-geography into China, as well as benefitted the development of time-geography in Japan. Finally, Arai switched his research interest into ICTs and daily life. The academic life path of Yoshio Arai is shown in Figure 1.

2.1 Time-geography's beginnings in Japan

Time-geographic studies began in Japan before anywhere else in East Asia, which was probably the earliest start after Europe and the United States. Japanese geographers were first informed about time-geographic studies in the mid 1970s, shortly after their birth in Sweden. A representative geographer who introduced quantitative geography to Japan, Professor Teruo Ishimizu at Nagoya University, had visited Lund University. His book, "An Outline of Quantitative Geography", was published in 1976 and it was the first Japanese textbook on quantitative geography (Ishimizu, 1976). His book included an explanation of the modelling of migration and Hägerstrand's theory of spatial diffusion. He concluded with a discussion of time-geography as the latest research trend. In his book, he used the English name, i.e. "time-geography", since the Japanese translation "Jikan Chirigaku" had not yet been coined.

"Jikan Chirigaku" may have been used for the first time in a 1985 paper written by Keiji Kushiya, which was published in the Geographical Review of Japan (Kushiya, 1985a). Kushiya's paper, which was titled "Time-geographic interpretation of fisherman's daily activity on Tokyo Bay, Japan", is the earliest empirical study to focus on people's daily activities from a time-geographic perspective. Kushiya's work was not popular among Japanese geographers, however, because it explored a ontypical case, i.e. the daily activities of fishermen.

2.2 Japanese retail industries: Business trends and their interest in "time"

Yoshio Arai first heard about time-geography around the time Kushiya's paper was published. At that time, he was teaching business administration and studying retail

geography. Therefore, he was interested in new forms of retailing in Japan.

At that time, convenience stores were attracting much attention. Time is a decisive factor for convenience stores, in that the store should be open from the early morning to late at night. For example, 7-Eleven is a convenience store chain that originated in the United States and is the largest convenience chain both in Japan and in the world. Its name means "service from 7 o'clock to 11 o'clock", which suggests that time had become recognised as a principal issue in this retail industry.

The critical issue behind Japanese retailers' attention to time was their interest in the so-called "time-shift business." Time-shift business refers to a business model with operating times that are extended beyond traditional times. Convenience stores and midnight restaurants are typical examples of time-shift businesses. In addition to these new forms of retail and restaurants, businesses appealing to time factors, such as "overnight delivery services" or "same-day delivery services", became popular. New flexible working styles were also proposed, such as the Flextime system. Thus, the interest in time increased in every industrial sector during this period.

The Japanese government paid attention to this increased interest in "time". A report edited by the Economic Planning Agency titled 'Time and Consumption' observed the growing importance of time-consuming consumption and time-creating consumption (Economic Planning Agency, 1987). The reports listed several examples of businesses corresponding to these new types of consumption, such as urban amusement parks, gourmet lifestyles, vacation homes, food delivery services and home shopping. By the mid-1980s, Japan was in an "era of time".

Given these trends, Arai considered convenience stores as an additional target for his research studies in the field of retail studies. He attempted to apply the concepts of time-geography as a theoretical framework to the study of time-shift businesses.

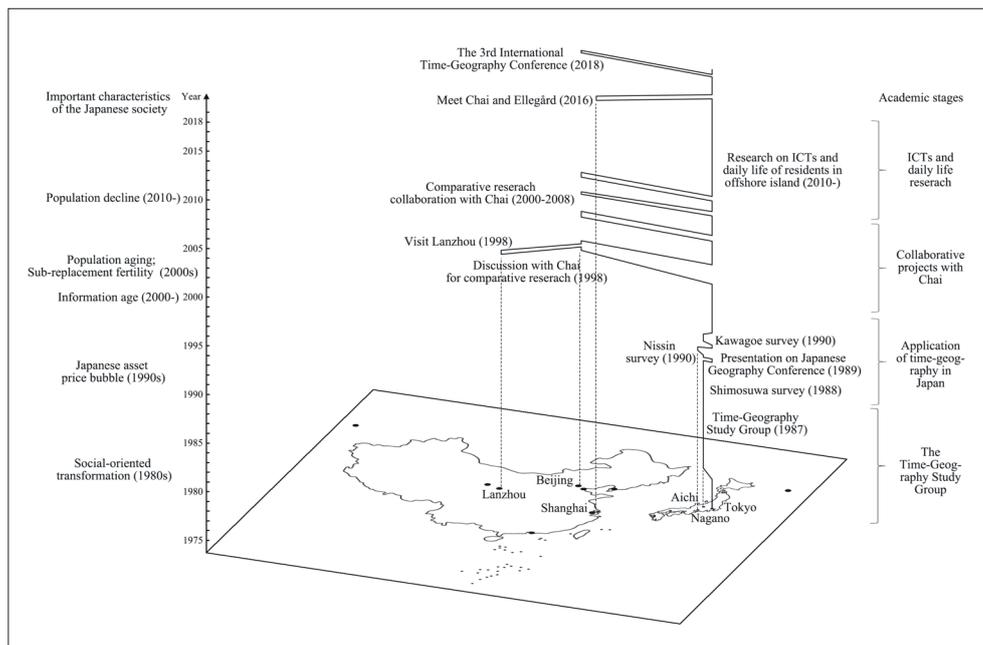


Fig. 1: Important characteristics of the Japanese society, the individual life path showing the locations and years of Arai's geographical movements and main academic activities, and the academic stages of Arai
Source: authors' elaboration

2.3 Establishing the Time-Geography Study Group

To his credit, however, Arai realised that he could not fully grasp the time-geographic perspective because he was unable to obtain the materials introducing the research methods and study cases in this research field. Therefore, he attempted to gather as many articles as possible, read them and sort them out. He also tried to encourage other people to collect time-geographic literature. Several graduate students from the University of Tokyo and Nagoya University responded to his private call for collaboration. In February 1987, they held their first meeting, and the “Time-Geography Study Group” was formed. The initial members of this group were Taro Kawaguchi and Satoru Hiromatsu from the University of Tokyo, and Kohei Okamoto and Hiroo Kamiya from Nagoya University.

The Time-Geography Study Group met approximately 20 times over about two years, and they discussed many domestic and foreign articles. Thus, the entire field of time-geography could be captured through their work. In the discussions during the meetings, they shared an intention to publish the outcome of their group work and make time-geography widely known not only to geographers, but also to stakeholders concerned with the social issues of urban society. Representative articles were selected from the time-geography field and translated into Japanese in order to publish an anthology. Eight articles in total were finally selected, and the anthology, “Space of Life Time in the City”, was published in the spring of 1989 (Arai et al., 1989).

2.4 Empirical study of the daily activities of urban residents

After publishing the anthology, Arai and the other group members thought that the next step would be empirical studies in Japanese cities; however, they were not sure about what method to use in this study.

The first challenge was the acquisition of daily activity data, which would provide the necessary materials for the empirical study. They considered using existing official

statistics, such as person-trip surveys. But there was no alternative but to conduct original surveys because of the limitations of the sampling methods and data items in the existing statistics.

Fortunately, the group had the opportunity to conduct a survey to collect basic data materials to establish a promotion policy for local retail businesses. This survey was conducted in Shimosuwa Town, Nagano Prefecture, which was close to Arai’s university at that time. As mentioned earlier, the possibility for time-shift businesses was a ‘hot’ topic in Japanese business society. This survey targetted the daily life of residents from a “space and time” perspective. The framework of the survey was a good fit for time-geography.

The next challenge was to design the questionnaire. They took note of the “Activity Approach”, which was developed in transportation planning. In particular, a 1983 report, Understanding Travel Behaviour, by the Transport Studies Unit (TSU) at Oxford University, drew their attention; it proposed using an “activity diary” to collect the details about people’s daily activities (Jones et al., 1987). Thus, the activity diary concept was applied in the design of the survey questionnaire. The final version of the questionnaire was consistent with an activity diary, as it recorded the activities successively on the investigation day, and a trip record, as it collected the details of trips made on the same day (Fig. 2). The respondents were requested to complete both forms.

Through the Shimosuwa study, the framework of time-geographic research was established. They then planned daily activity surveys in large metropolitan areas as the next step. It took nearly two years to obtain a research grant and conduct the surveys. Two daily activity surveys were conducted: one at Nishin Town in the suburbs of Nagoya early in the summer of 1990, and the other at Kawagoe City in the suburbs of Tokyo in the fall of 1990.

The data collected from these three surveys were analysed from various perspectives, and the results were published as “Space and Time in the City” (Arai et al., 1996).

Fig. 2: Final version of the questionnaire used in Shimosuwa survey
Source: authors’ elaboration

2.5 Characteristics of Japanese city life revealed by the daily activity surveys

Some basic characteristics of Japanese city life were revealed in the data collected from the daily activity surveys conducted in the three Japanese cities. Arai and his colleagues were impressed by the fact that gender was the most fundamental feature of daily activities in Japanese cities. Although these three cities were different in location and size, the temporal patterns of going out were quite similar in the three cities. Obvious differences could be seen in the patterns of male and female activities. Almost all husbands left their homes at approximately 8:00 am and returned at approximately 6:00 pm on weekdays. Most wives, however, went out between 10:00 am and 4:00 pm, with no more than 70% of wives leaving their homes daily (see Fig. 3).

A close examination of the activity patterns shows some characteristics of the work conditions for married women in the cities. The proportion of women who were not working was quite high for mothers with infants. Although the number of working mothers gradually increased after their children reached school age, they only went out for short periods because most of them worked part-time.

When he saw these results, Arai intuitively knew that Japanese time-geographic studies could contribute most effectively to the issue of “quality of life” for mothers with small children. Thereafter, he and his research team continued to analyse the influence of child rearing on mothers’ quality of life. These analyses showed that Japanese childcare systems and day care facilities could not sufficiently meet the recent actual conditions and needs of Japanese society. Consequently, Japanese mothers must endure all the stress from this mismatching of facilities and needs.

Today, the Japanese government has proposed to “build a society where women can succeed.” On the other hand, they have been aware of this issue for 30 years!

2.6 Penetration of the interest in quality of life and the “geography of daily life”

Since the publication of “Space and Time in the City”, Japanese geographers have become aware that the “quality of life” can be a matter of geographical study, which is

also related to the background of population aging, sub-replacement fertility and population decline, faced by Japanese society in the 2000s and 2010s.

For instance, one of Arai’s former students, Mikoto Kukimoto, pursued her studies of child rearing and mothers’ quality of life and completed her doctoral thesis. Her thesis is probably the first geographical thesis to consider the issue of child rearing. In 2016, her thesis, including later study results, was published as “Geography of Childcare and Parenting Support” (Kukimoko, 2016).

Hitoshi Miyazawa and his colleagues at Tokyo Metropolitan University proposed analysing local welfare conditions using the new mapping and GIS techniques in their 2005 book, “Applied Cartography and GIS for Welfare and Well-being” (Miyazawa, 2005). They employed activity dairies similar to Arai’s survey to deal with the issues of gender and women’s social participation. In addition, they applied simulation techniques based on Lenntorp’s method (Lenntorp, 1976).

Thus, the interest in the various challenges experienced by women and the elderly during their daily lives has increased since the end of the 1990s. A new study field was established, namely, the “Geography of Daily Life.” Representative publications are “Urban Spaces of Working Women” by Yoshimichi Yui and colleagues; “Women’s Employment and Life Space”, edited by Yoshimichi Yui; and “Geographical Analysis of Social Services for the Elderly in Japan” by Shinichiro Sugiura (Sugiura, 2005; Yui et al., 2004; Yui, 2012).

The daily life and welfare of suburbanised residents and factory workers also received attention from one of the Time-Geographical Study Group members, Kohei Okamoto, and his student, Yuichiro Nishimura. Okamoto (1997) investigated the daily lives of suburban people and their relationship to the suburbanization of Tokyo. Nishimura and Okamoto (2001) examined the daily lives of workers undertaking two shifts, day and night, in Toyota automobile factories.

Meanwhile, the issue of the consistency of women’s work and child rearing lives is one of the main study objects in the geography of daily life. These studies are strongly influenced by previous time-geographic studies. It is sure that Arai’s work exposed the problem from a time-geographic perspective and made some significant contributions to the development of this new study field.

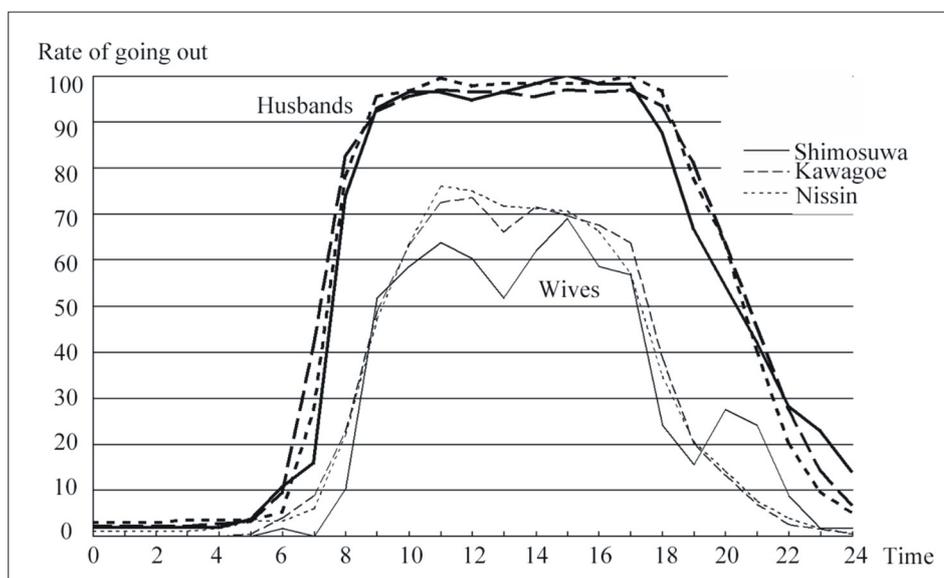


Fig. 3: Temporal patterns of going out in Japanese cities. Source: Arai et al., 2008

2.7 Diffusion of time-geography into East Asia

The focus on empirical studies on quality of life has been a feature of Japanese time-geographic studies. This feature appears to have diffused to neighbouring countries. For example, Arai and Chai conducted a joint comparative study, which helped gain an understanding of urban life in both countries from a time-geographic perspective.

In this study, Arai took charge of the comparative analysis of the general characteristics of daily activities between Japanese and Chinese cities. The results were striking. In contrast to the Japanese cases, the difference by cities was clear, but fewer gender differences were found in the Chinese data (see Fig. 4).

From the beginning, childcare facilities and services in Chinese cities were established to enable both parents to work full-time. For a long time, however, many Japanese have been conscious that it is difficult for both parents to combine careers and child rearing. Nevertheless, the Chinese experience shows that this attitude might be misguided.

Since this comparative study, the condition of childcare services in Japanese cities has largely improved. The standards of services in Japanese cities, however, have not yet matched those in Chinese cities. The issue of children on waiting lists has drawn wide social interest in recent years. Despite a slogan by the Japanese government, “Success of Women in the Workplace”, many challenges remain.

2.8 ICTs and daily life research

Arai changed his research interest to ICTs and the daily life of residents on offshore islands after the joint comparative study with Chai in 2008. Several articles were published, including those on government policy, Internet access, and the daily activity of residents in low-density areas, such as the offshore islands (Arai et al., 2012; Stake and Arai, 2013, 2017).

Although there has been no remarkable progress in time-geography since the mid-2000s in Japan, probably due to strict concerns about privacy derived from individual data from GPS and mobile phones, Arai’s research was still influenced by time-geography and behavioural perspectives.

3. Academic life path of Yanwei Chai and the diffusion and development of time-geography in China

Chai first learned time-geography when he was studying in Japan. Two activity diary surveys were conducted in Hiroshima and Lanzhou with the help of Arai. After he returned to China, Chai continued his time-geography research and cooperated with Arai for the joint comparative study. Since 2010, Chai has contributed to innovations in time-geography methodology and urban planning studies. He has also communicated with international

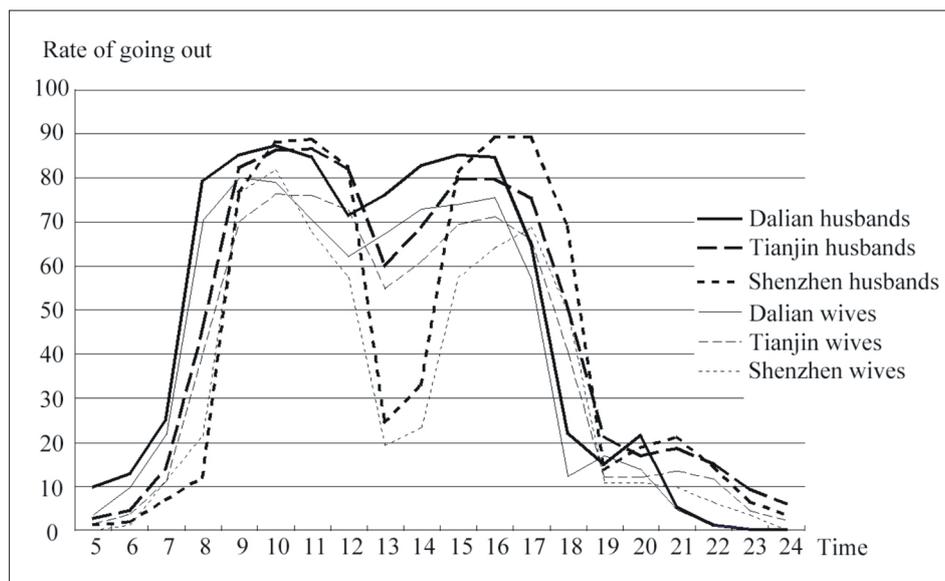


Fig. 4: Temporal patterns of going out in Chinese cities. Source: Arai et al., 2008

time-geographers extensively, which considerably helped his research. Chai’s academic life path was tightly related to the development of Chinese cities. The academic life path of Yanwei Chai is shown in Figure 5. The two main backgrounds that significantly influence Chai’s academic life are the rapid urbanisation and suburbanisation experienced by Chinese cities, especially after the reform of the housing system in 1998, and the “New Urbanisation” policy, which accelerated social-oriented transformation in Chinese society.

3.1 Before exposure to time-geography

Chai was studying geography in Northwest Normal University in Lanzhou for his bachelor degree. At that time, influenced by the Soviet Union, the distribution of industry was the focus of economic geography. The main method of

research was regional description, and quantitative analysis was seldom performed. Even during his master’s study, Chai had never had an opportunity to read an English article or book on geography and had never heard about urban geography, behavioural geography and time-geography, because of a lack of resources and rigid thinking. Regardless, Chai was active in promoting a revolution in Chinese geography. He held and participated in several workshops and forums for young geographers and learned about the quantitative revolution for the first time in 1985.

3.2 Initial learning about time-geography

In 1988, Chai was chosen as an exchange student to Hiroshima University in Japan, sponsored by a Japanese Government Scholarship. The exchange program changed his academic life substantially.

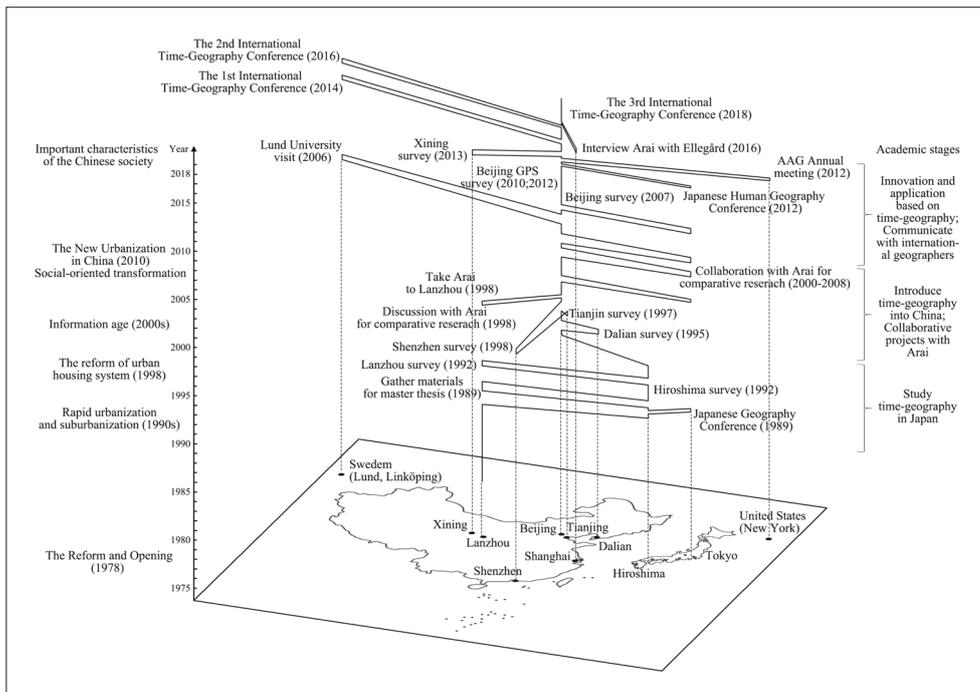


Fig. 5: Important characteristics of the Chinese society, the individual life path showing the locations and years of Chai's geographical movements and main academic activities, and the academic stages of Chai
Source: authors' elaboration

Chai first saw the term “time-geography” in the graduate entrance examination in Human Geography at Hiroshima University in 1989. The exam asked students to explain each term; however, Chai did not know what time-geography meant at that moment. On the other hand, this shows that time-geography was known well enough by Japanese geographers.

After that, Chai learned about time-geography by reading published papers and books and by attending presentations, especially by the Time-Geography Study Group. The first time-geographic article read by Chai was the review and research of fisherman's daily activity by Kushiya (1985a, 1985b). The first time-geographic research presentation heard by Chai was the time-geography session organised by Arai and other group members in the Japan Geography Conference in 1989. The first time-geographic book studied by Chai was “Space of Life Time in City” (Arai et al., 1989). Although Chai thus first studied time-geography because of the introductory work of the Time-Geography Study Group, he seldom thought of using it in his academic research.

3.3 Preliminary application of time-geography during his graduate studies

The title of Chai's undergraduate thesis is “Research on Agriculture Geography in Qinhai Province” in China. Although he had a solid base in physical geography, Chai insisted on doing human geography research when he was facing the challenge of his master's thesis. Therefore, Chai chose urban spatial structure in Lanzhou as his research topic. In order to innovate, Chai's study analysed not only the structure of land use, but also the structure of residents' daily activity, i.e. the urban activity space.

He returned to Lanzhou in 1989 and gathered materials for research. During his research, Chai realised that danwei compounds play an important role in Chinese urban space. Danwei was the generic term indicating Chinese socialist workplaces. It provided employees not only with jobs, but

also residence and a bunch of daily services within its own realm (Bray, 2005). Therefore, danwei was the basic living space for Chinese urban residents, and more importantly, Chinese cities were organised based on danwei. Influenced by Japanese geographers, Chai used the concept of “life circle” and time-geography to describe and analyse the role of danwei in the organisation of residents' daily lives. Two of his articles were published (Chai, 1991, 1993), which greatly improved Japanese scholars' understanding of Chinese cities.

After completing his master's degree, Chai proposed a framework of a comparative study between Chinese and Japanese cities for his doctoral project. Time-geography was used to analyse daily activity in both countries. Chai, however, did not know how to design the questionnaire and collect activity data. Fortunately, Arai sent him the daily activity questionnaire used in the Shimosuwa survey (Fig. 2) to help fix the problem.

Chai conducted his activity diary surveys in both Hiroshima and Lanzhou, with a sample of 400 households and 800 diaries (half workdays, half weekends) in 1992. Two articles about the activity space of residents in both cities were published (Chai, 1993, 1994). Chai's doctoral thesis, which compared the land use and activity space structures of Hiroshima and Lanzhou, was published in Japanese as well as Chinese (Chai, 1999). The methods Chai used in his several time-geographic studies to analyse and visualise residents' daily activities were highly influenced by the papers published by the Time-Geography Study Group. Taking the visualisation of individual paths as an example (see Fig. 6), we can easily find similarities between Kamiya et al. (1990) and Chai (1999).

3.4 Introduction and application of time-geography in China

Chai returned to China after completing his doctorate in 1994. He became a post-doctoral student and further an Associate Professor at Peking University. During the

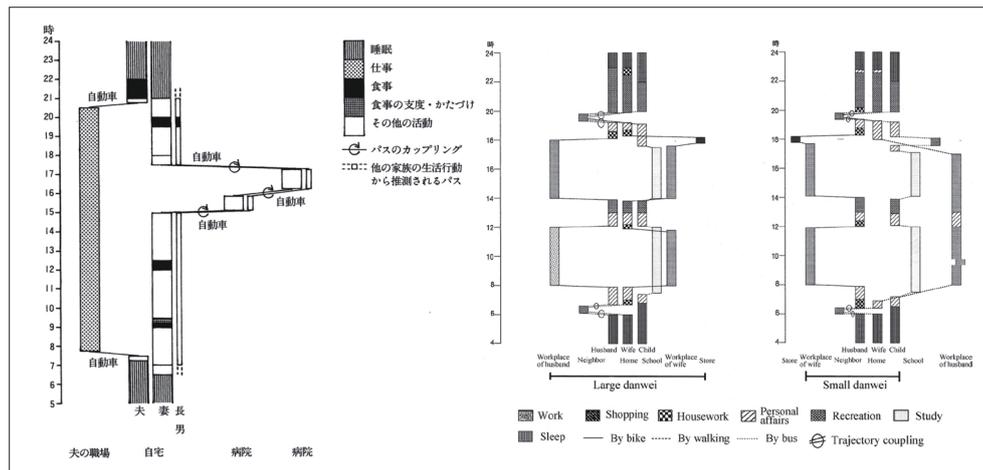


Fig. 6: Daily activity paths of family members illustrated in Kamiya et al., 1990 (left) and Chai, 1999 (right)

period 1994–2000, he undertook four research projects, which concerned the application of time-geography in urban spatial structure, travel behaviour and urban planning studies. Besides, Chai and his research team published some introductory papers, including basic concepts and the methodology of time-geography, and reviews of time-geographic research in other countries (Chai and Wang, 1997; Chai, 1998; Chai et al., 2000; Chai and Gong, 2000; Chai et al., 1999). These papers, for the first time in China, introduced time-geography and an individual-based research perspective and methodology. Three activity diary surveys were conducted in Dalian (1995), Tianjin (1997) and Shenzhen (1998) by his research group. A series of articles were published, which were then selected and published as “Spatio-Temporal Structure of Chinese Cities” (Chai et al., 2002). The key idea of these papers was to understand urban spatial structures from the perspective of individual activities.

A comparative study of residents’ daily activities in Japanese and Chinese cities, in collaboration with Arai, was conducted from 2000 to 2008. More detailed information about this cooperative work is discussed in Section 4, below. Although the results of this comparative study contributed to the understanding of both Japanese and Chinese cities, Chai thought that the analytic methods lacked innovation. The methods used in most of the research consisted of aggregating daily activity data and illustrating it in figures and tables, or just visualising individual daily activity paths. The reasons behind the activity patterns were mainly inferred from interviews. Few quantitative methods were used to test the hypotheses. Therefore, he turned to research based on the theory and methodology of behavioural geography.

Chai received research funding from the Natural Science Foundation of China (NSFC) for work on behavioural geography in 2002, and a series of articles about consumer behaviour was published, including space-time characteristics, influencing factors and decision-making processes. Chai was regarded as the leader of Chinese behavioural geography at that time. Related research was summarised and published as “Urban Space and Consumer Behaviour” (Chai and Zhang, 2010). In addition, the daily behaviour of the elderly was also studied in this period. The results were published in “Activity Space of the Urban Elderly in China” (Chai, 2010). Behavioural geography research is hard to continue, however, because it lacks theoretical foundation and is usually regarded as merely mathematical models. There had not been substantial progress in global behavioural geography for some time after

Reginald Golledge’s work. Besides, mixed methods research (the combination of qualitative and quantitative research) was gaining much attention at that time. Therefore, Chai decided to turn back to time-geography.

3.5 Methodological innovations and urban planning applications based on time-geography

The first challenge taken on by Chai was to think further about the previous time-geographic research paradigm. The quantitative analytical perspective and methods in behavioural geography research provided an important basis for innovation. Chai and his research group tried to reflect the socio-spatial reconstruction happening in Chinese cities by investigating the interaction between space and behaviour. Time-geography emphasises the influence of societal and technological change on human behaviour. By analysing the influencing factors of behaviour, we can understand urban transitions, such as housing system reform and suburbanisation, from a behavioural perspective. Based on this perspective, Chai proposed a new research framework and received another grant from the NSFC in 2007.

A new activity diary survey in Beijing was conducted in 2007. Despite similar questionnaires, new analytical frameworks and tools were employed. Many articles using this dataset were published, and one of the most influential works was on the effects of danwei on residents’ space-time behaviour patterns, such as home-work relationships, travel behaviour, trip rates and time spent on out-of-home activities (Wang et al., 2011; Wang and Chai, 2009). Suburbanisation was also found to have a great influence on travel behaviour, activity spaces and out-of-home non-work activities (Ta et al., 2016; Ta et al., 2015; Shen et al., 2015; Shen and Chai, 2013). The results based on this new dataset were published in “Spatial Behaviour and Behavioural Space” (Chai, 2014a). Moreover, the change in activity patterns was due to urban transformation; meanwhile, behavioural change could affect environmental sustainability and the quality of life. Hence, recent trends were observed in socio-spatial segregation (Zhang et al., 2018; Wang et al., 2012), environmental pollution (Ma et al., 2015; Liu et al., 2017) and health geography (Ma et al., 2020; Ma et al., 2017) from the perspective of space-time behaviour.

Another innovation was implementing different data collection methods. Learning from space-time behaviour research in Western countries, Chai and his research team started integrating GPS and mobile telephone tracking

technologies into classical activity diaries to collect more accurate and real-time activity information. A pilot survey with a sample of 100 individuals was conducted in Beijing in 2010 with the support of the IBM Company. Participants were asked to carry a mobile tracking device with built-in GPS and mobile telephone chips over a week and to complete activity diaries through an online survey platform (Chai et al., 2013; Huang et al., 2010). Another survey using the same data collection method with 709 respondents was conducted in the Shangdi-Qinghe area in Beijing in 2012, under the auspices of the National Science and Technology Support Program (NSTSP). Guided by the uncertain geographic context problem (UGCoP) proposed by Kwan (2012), portable air pollution and noise sensors were furtherly integrated with GPS and activity diaries during data collection, to avoid contextual uncertainties in health and social science research (Kwan, 2018). The research teams of Chai and Mei-Po Kwan conducted surveys using the same data collection method in both Beijing and Chicago, under a China-US joint research project supported by the NSFC. Accompanied by innovations in the data collection method, Chai also made progress in analytical methods: GIS-based disaggregate-level methods were developed to visualise and analyse real-time high-resolution space-time behaviour data (Chen et al., 2011; Shen et al., 2013).

Applying space-time behaviour research to urban planning and governance was another innovation Chai and his research team made during these years. Based on the collection and analysis of behavioural data, Chai established a smart travel planning framework and accomplished a demonstration project in the Shangdi-Qinghe area supported by NSTSP (Chai and Chen, 2018). On the one hand, by acquiring, visualising and analysing individual travel data and real-time position, related agents could provide personalised travel information to support travel decisions and realised travel planning. On the other hand, by analysing and simulating aggregated travel patterns and needs, the government could adjust and optimise traffic infrastructure and service systems (Chai et al., 2014). Another application of time-geography and the space-time behaviour approach was to life circle planning. Life circle, the concept borrowed from Japanese geographers, has had a great influence on Chai's academic life. In early research, Chai found that danwei is the primary unit of Chinese urban society and can be seen as a daily life circle (Chai, 1996). Although the danwei system collapsed after the housing system reform, its initial aim to fulfil the basic needs of residents' daily behaviour is still valuable for today's planning practice (Liu and Chai, 2015). Chai's research team proposed the theoretical urban life circle planning framework and then tried to integrate it into the current planning system (Chai et al., 2015; Sun et al., 2016). One of the projects was to optimise the supply of public infrastructure based on the concept of community life circles, which was cooperative work with the Beijing Municipal Institute of City Planning & Design (Sun and Chai, 2017).

In addition to innovations and applications based on time-geography, Chai continued his pioneering work on time-geography in China. Two important special issues were organised by Chai in Chinese journals of geography and urban planning. The first is "Time-Geography and Urban Planning" published in "International Urban Planning" in 2010, which introduces international research advances on GIS methods in time-geography, as well as some theoretical thinking about a combination of time-geography and Chinese urban planning (Chai et al., 2010). The other special issue aimed at introducing recent advances of a theoretical nature and the

application of time-geography and space-time behavioural research, which was published in "Progress in Geography" in 2013 (Chai and Ta, 2013). The "Frontier of Space-Time Behaviour Research", edited by Chai, was also published in 2014, which summarised theoretical, methodological and application-related progress in space-time behavioural research (Chai, 2014b). Meanwhile, Chai extended his research network during this period. The Urban China Spatial-Temporal Behaviour Research Network (UCSB) was established, and several international exchange and cooperation activities were conducted with top researchers in this field, such as Mei-Po Kwan, Shih-Lung Shaw, Harvey Miller, Martin Dijst, Tim Schwanen and Rein Ahas.

3.6 Recent trends: Towards a "new" time-geography

After attending time-geography sessions at the AAG Annual Meeting in 2012 and participating in the first and second International Time-Geography Conference in Sweden in 2014 and 2016, respectively, Chai decided to apply to an exchange and cooperation project with Swedish time-geographers in order to promote theoretical innovation in China. Kajsa Ellegård from Linköping University, Sweden, and Chai jointly applied for this grant, which was co-funded by the NSFC and Swedish Foundation for International Cooperation in Research and Higher Education (STINT). Research groups from both sides were exchanged each year from 2014 to 2018 by organising seminars, giving lectures and teaching. The 3rd International Time-Geography Conference was also held at Peking University during this period.

The achievements of this project are surprising. Chai and his research group refreshed their understanding of time-geography, which is called the "new" time-geography in Chinese. The concepts of 'project' and 'pockets' of local order (POLO) and other undiscovered knowledge of time-geography have been gradually understood since then. Recent progress made by Swedish time-geographers also came into view for the first time. Related introductory articles were published by Chai and Ellegård in a special issue of "Human Geography" in Chinese (Zhang and Chai, 2016).

Currently, Chai and his research team have completed the introductory work on the "new" time-geography by articles and lectures across China. They are now undertaking empirical research based on the new knowledge they have learned. A series of articles and a Chinese time-geographic textbook will be published in the near future.

4. Interaction between and comparison of academic life paths

4.1 Summary of key events and interactions

Yoshio Arai and Yanwei Chai have played an important role in the diffusion and development of time-geography in Japan and China, which can be concluded from their academic life paths. Moreover, there exist some key events during this process, and most of the key events are interactions between Arai and Chai, which considerably help promote time-geography in their countries. In chronological order, the key events and interactions are shown in Figure 7 and are also summarised and analysed below.

4.1.1 Interactions during Chai's studies in Japan

The establishment of the Time-Geography Study Group and the publication of the anthology of time-geographic classic articles by Arai and other scholars, can be regarded as iconic

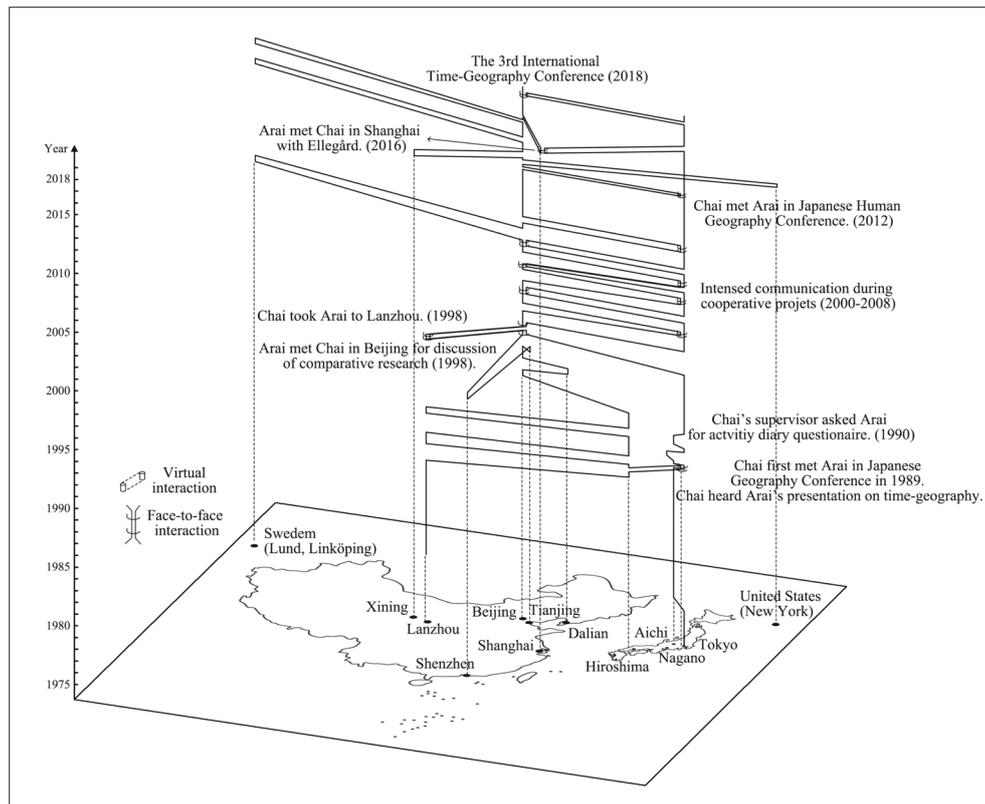


Fig. 7: Interactions (virtual and face-to-face) of the academic life paths of Arai and Chai
Source: authors' elaboration

events that promoted the diffusion of time-geography in Japan. Their empirical studies developed time-geography in Japan and enabled Japanese scholars to better understand the daily activity and quality of life of urban residents. In 1989, Arai and other group members participated in the annual Japanese Geography Conference in Tokyo. It was at that time that Chai met Arai for the first time and heard his first presentation on time-geography. Chai was impressed by Arai's speech and decided to learn time-geography through the works of the Time-Geography Study Group. The anthology provided a good start for him to learn time-geography systematically.

Arai further provided help during Chai's empirical study. When Chai was going to conduct his own activity diary surveys in Lanzhou and Hiroshima, Arai provided the questionnaire used in the Shimosuwa, Nissin and Kawagoe surveys. The same questionnaire and the data collection method they used also helped their joint comparative study in the next stage. Moreover, Chai learned much about the research ideas, analytical methods and visualisation techniques from the empirical studies conducted by Arai and his Time-Geography Study Group members. These interactions, though virtual in some cases, strongly influenced Chai's academic life and brought time geography into China indirectly. We could see this influence continue with Chai's earlier research, which provided a unique behavioural perspective for Chinese urban geographers to understand urban spatial structure. In his introductory works of time-geography to China, Chai also directly referred to the translation and definition of some important concepts by Japanese geographers, such as activity space.

4.1.2 Interactions during the joint comparative study

After Chai returned to China, the most important interaction between these two scholars was the joint

comparative study. In 1998, Arai had the opportunity to visit Chai in Beijing. Chai showed Arai around Beijing and took him to Lanzhou for a visit, where Chai had conducted an activity diary survey in 1992. This visit aroused Arai's interest in Chinese cities. Therefore, Arai and Chai planned the joint study, which aimed to compare cities in Japan and China based on the activity data collected by previous surveys conducted by them. The survey data could be compared easily because the Japanese and Chinese surveys used similar questionnaires.

The comparative analyses were conducted between 2000 and 2005 with support from the Japanese Government's Grants-in-Aid. The Japanese members were Yuko Tahara from Kokugakuin University, Kohei Okamoto and Arai. In addition, graduate students from the University of Tokyo and Nagoya University also joined the Japanese team. In China, the "Study Group on Behavioural Geography at Peking University" joined the collaboration. The research topics included urban activity systems, activity space and the welfare of disadvantaged groups, and adjustments in household employment and housework activities. A special issue was published in "Komaba Studies in Human Geography" in 2003 (Arai, 2003; Okamoto, 2003; Chai and Liu, 2003; Tahara, 2003; Nishimura, 2003). In 2008, the results from this comparative study were published as a Japanese book, "Activity Space in Chinese Cities" (Arai et al., 2008).

The comparative study helps promote understanding of both Chinese and Japanese cities. Through comparison, the reasons why Japanese families were facing serious childcare problems have been elucidated, and the misguided attitude that women must quit full-time jobs for child rearing has been changed. In terms of China, the role *danwei* plays in urban life had been emphasised again.

4.1.3 Interactions after the comparative study

Most interactions occurred between Arai and Chai via virtual means after the collaborative project; however, Chai still met Arai and other members of the Time-Geography Study Group on occasion. In 2012, Chai went to Japan to attend the annual Japanese Human Geography Conference. Chai talked with Arai and realised that he had changed his research interest, partly because it was hard to conduct GPS surveys or collect mobile telephone data due to privacy concerns, although it was at the frontier in time-geography and behavioural research at that time. After a discussion with Arai and Okamoto, however, Chai decided to stick to time-geography and started a new GPS survey in Beijing. The reason that Chai continued to follow the new trend in time-geography was that China was just entering the social-oriented transformation stage after the government released the “New Urbanisation” policy in 2010. Society needed individual-based research and behavioural research in order to improve the quality of life. At the same time, Japanese society started social transformation early in the 1970s and it was facing new problems. Moreover, there were few new generations of time-geographers in Japan. Yuichiro Nishimura from Nara Women’s University is probably the only one after the generation of Arai and Okamoto. He tried some new techniques such as GPS and GIS in his early research (Nishimura et al., 2008), but the survey was conducted in Laos, and it was hard for him alone to continue such research in Japan.

In 2016, Arai met Chai and Ellegård in Shanghai. Ellegård was working on her project aimed at an overview of time-geography and its development, diffusion and future, through meetings and interviews with international researchers at that time. Chai helped Ellegård’s interview with Arai and Okamoto, and they also wrote a chapter in the book edited by Ellegård, “Time-Geography in the Global Context”, to summarise time-geographic research in Japan (Okamoto and Arai, 2018). At the 3rd International Time-Geography Conference held at Peking University, Chai and Arai had another chance to meet again, and they introduced the development of time-geography in their countries

separately. In addition, after several years of innovation and the refreshment of time-geography, it is Chai that continues to give lectures on advances in space-time behavioural research and their applications, as well as the “new” time-geography in Japan.

4.2 Comparison of academic life paths

Similarities and differences exist between the academic life paths of Arai and Chai. Both scholars knew and learned time-geography from published articles and books. Both research groups shared common research topics which applied time-geographic theory and methods to urban issues. For example, Arai and his group applied time-geography in urban life and clearly demonstrated factors influencing the quality of life of women and the elderly. Chai and his team analysed residents’ daily activities based on time-geography, to reflect urban spatial structure and the huge socioeconomic transition occurring in Chinese mega-cities. In addition, Chai also attempted to apply time-geography and space-time behavioural research in urban planning and governance practices, such as life circle planning and smart travel planning.

The socioeconomic context (with respect to broader country conditions) of their academic life is also quite similar (see Fig. 8). When Arai and other members of the Time-Geography Study Group decided to systematically learn and use time-geography in the 1980s, the urbanisation level of Japan was very high (76.7% in 1985). Quality rather than quantity was the emphasis in the next urbanisation stage. Meanwhile, Japanese society was facing problems of an aging population, gender inequality and declining birth rates. Therefore, time-geography provided a unique tool to analyse individual daily lives, especially of the aged and female groups, in order to improve their quality of life (Sugiura, 2005; Yui et al., 2004; Yui, 2012). For Chai, although the urbanisation level of China was not high when he returned, the urbanisation level of Chinese mega-cities was high. For example, the urbanisation level of Beijing in 1995 was 75.6%. In addition, if we look at the innovative and influential work by Chai from 2007 to 2014, the

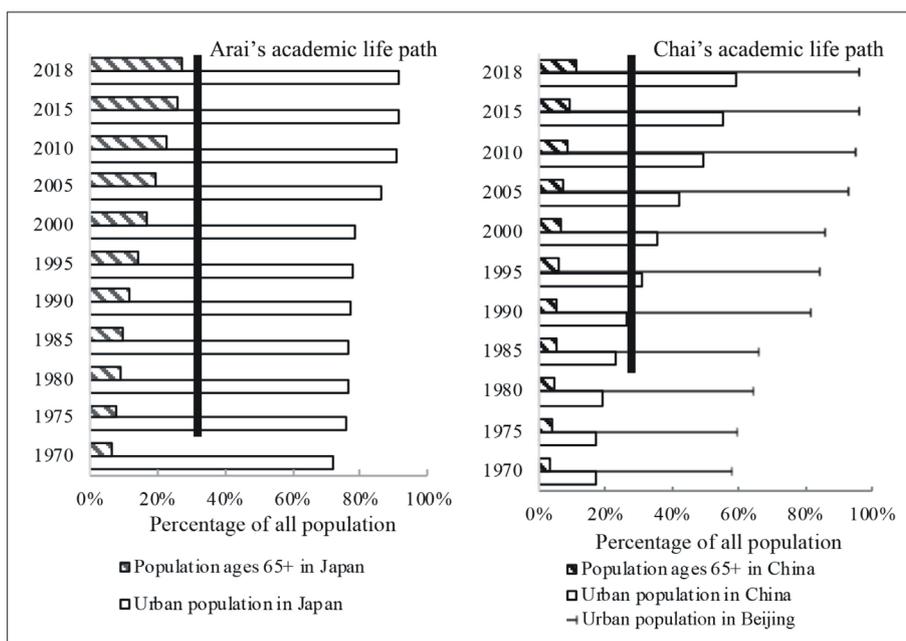


Fig. 8: Socio-economic backgrounds of academic life paths of Arai and Chai
Source: authors’ elaboration

urbanisation level across all of China was also 50%, which means it was entering a quality-first stage. Besides, Chinese society faces similar problems, such as population aging and social inequality. In fact, similar problems arising from rapid urbanisation and large-city growth were also faced by Torsten Hägerstrand, when he put forward time-geography in Sweden (Ellegård, 2018b; Pred, 1973). Therefore, this similar socioeconomic background indicates that the academic life paths of Arai and Chai are tightly related to societal context.

There are also differences between their life paths. Arai has switched his research interest to ICTs and daily life since the mid-2000s, while Chai has continued his time-geography research until the present. Although Arai and his colleagues have accomplished valuable work, few English papers have been published, and they seldom communicate with other researchers, especially those from Western countries. In contrast, Chai has extended his research network with top researchers in this area internationally, which promotes his innovations directly.

5. Discussion and conclusion

This article has provided an overview of the diffusion and development of time-geography in East Asia. Specifically, it summarised how time-geography was introduced and promoted in Japan and China from the perspectives of the academic life paths of Yoshio Arai and Yanwei Chai. The life path analysis is employed because these two scholars have played an important role during this process. The development of time-geography in both countries goes hand in hand with the academic progress made by them. Moreover, there are some interactions between their academic life paths, which mark some key events that promoted time-geography significantly. Finally, this article analysed the similarities and differences between their academic life paths. Both scholars learned time-geography through published English or Japanese articles on time-geography, and they also shared some common research topics in the early stages. In addition, the socioeconomic backgrounds of their academic life paths are quite similar. There are still some differences, however, including their recent research interests and international communications.

Firstly, the academic life path method is demonstrated in this article to be a useful tool to depict the intellectual history of a certain discipline and to analyse the role of key individuals in this process. Compared with conventional literature reviews, the academic life path method provides a clearer trajectory and more vivid information on how the discipline develops. The time, place and contents of the important academic events are clearly visualised on the path, as well as the socioeconomic background and the academic stages. The importance of key individuals and their interactions are also highlighted by this method. Besides, the path can be described at different temporal scales depending on research objectives. For example, we can focus on the joint comparative study and depict the interactions between Arai and Chai during the period 2000–2008 in detail, if we want to analyse how the joint study was completed and its influence on Japanese and Chinese academies and societies. A broader overall view of the development of the discipline cannot be shown by this method, however, and that is the strength of a systematic literature review.

Secondly, the application of the academic life path method in studying the diffusion and development history of time-geography provides a good scheme for other disciplines.

Most modern disciplines, especially in the social sciences, share similar diffusion and development patterns and characteristics with time-geography. They tend to have originated from Europe, and then diffused firstly into other Western countries, such as United States, and secondly into East Asia. In addition, like time-geography, the most prominent characteristics of the disciplines in East Asia are the innovative applications in some new research topics, which tightly relate to societal problems. Therefore, the life path method can be applied to learn the developmental trajectory of other disciplines and to understand the role of key scholars, in the important socioeconomic context of any comparative country analysis.

Finally, the diffusion process of time-geography in Japan and China is clearly visualised by these two scholars' academic life paths. Furthermore, the analysis of socioeconomic backgrounds of their paths reveals some mechanisms behind the diffusion and development of time-geography. Both scholars introduced and applied time-geography when societal-oriented transformations happened in cities. At that time, urbanisation rates were above 50% and it was quality rather than quantity that urban development focused upon. Human-based urban planning was proposed, which called for individual-based research to improve life satisfaction and the quality of life. Therefore, time-geography provided a novel and useful theory and method for these studies. The socioeconomic backgrounds faced by Arai and Chai also coincide to some extent with the context when Hägerstrand proposed time-geography in Sweden in 1970 (Hägerstrand, 1970; Ellegård, 2018b). And time-geography was soon applied in facilities adjustment, time allocations and travel requirements by his colleagues and students (Ellegård et al., 1977; Lenntorp, 1970). Hence, it can be concluded that the development of time-geography is tightly related to the socioeconomic context and promoted by practical demands. It can also be inferred that time-geography may be diffused to other developing countries, which are currently facing rapid urbanisation, such as India.

After spatial construction has entered a steady mode due to low levels of urban population growth and low birth rates, social construction becomes the major challenge in developed countries. Accordingly, time-geography has also developed in response to societal needs. In Sweden, time-geography has been applied to sustainable development, energy consumption and the impacts of ICTs in everyday life (Ellegård and Palm, 2015; Thulin and Vilhelmson, 2012). In the US, new research directions based on time-geography are sustainability, social segregation and health (Kwan, 2013; Park and Kwan, 2018; Song et al., 2017). In China, though still under the process of spatial construction, time-geography has been applied in the research of social differentiation, environmental exposure and health (Ma et al., 2020; Zhang et al., 2019). Hence, new trends in Sweden and the US were also introduced in China. In terms of Japan, Okamoto is currently studying daily activities and evacuation behaviours for natural disaster effects reduction based on time-geography. Except for his studies, there are few papers regarding this new social transformation, probably because of the lack of scholars as well as privacy concerns with respect to data collection.

In conclusion, this article finds that the diffusion of time-geography from the West to the East cannot happen without the hard work of some key scholars and their research teams. Early published English articles on time-geography are also quite important for the scholars in Japan and China, for

they helped researchers from all over the world to overcome geographical distance and know recent academic progress in the 1970s and 1980s, when there was no Internet. International cooperation also plays an important role during this process. Friendships among these researchers are created and deepened alongside exchange and cooperation activities, as time-geography is also developed because of their long-lasting relationships.

The 3rd International Time-Geography Conference held in Peking University in 2018 can be regarded as an indication that time-geography in East Asia has entered the international stage. In the next step, it is important for Asian time-geographers to strengthen exchange and cooperation activities and build international research networks. The annual China-Japan-Korea Joint Conference on Geography and the Asian Geography Conference can also be good opportunities for time-geographers to gather and communicate. The recent increase in international collaborative research and projects can also help promote this interaction. Moreover, time-geography in East Asia should go beyond application – to the innovation of theory and method. We should contribute to global time-geography with our characteristic Asian experiences.

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