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Towards a more comprehensive understanding of ethnic segregation: activity space and the vicious circle of segregation

UNIVERSITY OF TARTU
Press

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This dissertation was accepted for the commencement of the degree of *Doctor philosophiae* in human geography and regional planning at the University of Tartu on 5 April 2021 by the Scientific Council of the Institute of Ecology and Earth Sciences at the University of Tartu.

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Commencement: Senate Hall, University of Tartu, Ülikooli 18, on 10 June 2021 at 09:15.

The publication of this thesis is granted by the Institute of Ecology and Earth Sciences, University of Tartu.

ISSN 1406-1295
ISBN 978-9949-03-616-5 (print)
ISBN 978-9949-03-617-2 (pdf)

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University of Tartu Press
www.tyk.ee

In memory of Professor Rein Ahas

To my dear family

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LIST OF PUBLICATIONS

This dissertation is based on four publications which have been published in peer-reviewed international academic journals. Articles will be referred to in the thesis by their respective Roman numeral.

I **Mooses**, **Veronika**; Silm, Siiri; Ahas, Rein (2016). Ethnic segregation during public and national holidays: a study using mobile phone data. Geografiska Annaler Series B-Human Geography, 98 (3), 205–219. DOI: 10.1111/geob.12100.

II Silm, Siiri; Ahas, Rein; **Mooses**, **Veronika** (2018). Are younger age groups less segregated? Measuring ethnic segregation in activity spaces using mobile phone data. Journal of Ethnic and Migration Studies, 44 (11). 1797–1817. DOI: 10.1080/1369183X.2017.1400425.

III **Mooses**, **Veronika**; Silm, Siiri; Tammaru, Tiit; Saluveer, Erki (2020). An ethno-linguistic dimension in transnational activity space measured with mobile phone data. Humanities and Social Sciences Communications, 7 (140). DOI: 10.1057/s41599-020-00627-3.

IV Silm, Siiri; **Mooses**, **Veronika**; Puura, Anniki; Masso, Anu; Tominga, Ago; Saluveer, Erki (forthcoming). The relationship between ethno-linguistic composition of social networks and activity space: a study using mobile phone data. Social Inclusion, 9 (2). DOI: 10.17645/si.v9i2.3839.

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Author's contribution to the articles: '*' denotes a minor contribution, '**' denotes a moderate contribution, and '***' denotes a major contribution.

	I	II	III	IV
Original idea	**	*	**	**
Study design	**	*	**	**
Data processing and analysis	***	**	***	**
Interpretation of the results	***	**	***	**
Writing the manuscript	***	**	***	**

1. INTRODUCTION

Mobility is interwoven into the functioning of modern societies (Cresswell, 2011). Prior to the decline in overall human spatial mobility, the closure of borders, and the shrinkage of the transportation sector due to COVID-19, the figures for national and international spatial mobility were steadily increasing (involving commuting, tourism, and international migration). Both permanent and temporary spatial mobility contribute towards better access to socio-economic opportunities and the cultural, ethnic, and religious diversification of European societies. Such diversity on the one hand increases the human capital of states and boosts the tourism sector, but serves to challenge social cohesion on the other hand, which may result in tensions and conflict arising in society. Despite different integration strategies which target separate activity places (ie. mixing policies for residential space), life domains (ie. language courses for education and the labour market), and anti-discrimination laws, the spatial separation of different socio-economic and ethnic groups, ie. segregation, in different European cities is tending not to decline but can instead be seen to be on the increase (Musterd et al, 2017). This indicates that a deeper and more comprehensive understanding of the segregation process and its dynamics is necessary in order to be able to develop more effective integration policies.

Studies regarding migrant settlement processes date back to the early twentieth century and the Chicago School of Sociology, when the process was analysed primarily through the narrow lens of the spatial distribution of people's residential places (van Kempen & Özüekren, 1998). Dominant research of that period focused on segregation patterns in cities (eg. Burgess, 1928). Along with advancements in terms of analytical approach when it came to data collection methods, data sources, and analysis methods, segregation studies of the last decade have diverged into two directions. Firstly, longitudinal segregation studies from the spatial assimilation framework mainly focus upon the long-term residential trajectories of migrants (eg. van Ham et al, 2014; Vogiazides & Chihaya, 2020) and, secondly, activity space segregation studies which focus upon the full set of activity locations, domains, and short-term changes in segregation levels (eg. Järv et al, 2015; Silm & Ahas, 2014a, 2014b; Wang & Li, 2016; Wong & Shaw, 2011). Examples covering the latter include studies which go beyond residential place, being able to pay additional consideration to workplace (Ellis, Wright, & Parks, 2004), leisure time (Kukk, van Ham & Tammaru, 2019), spatial mobility (Shen, 2019), and whole activity space (eg. Järv et al, 2015; Toomet et al, 2015; Xu et al, 2019). The latest theoretical contributions towards segregation research go even further, covering segregation cycle (Krysan & Crowder, 2017) and the vicious circle of segregation (van Ham, Tammaru, & Jannsen, 2018) to indicate the interlinkages between all activity places and life domains and attempting to explain the transmission of segregation across activity places as well as generations. The latest theoretical advancements indicate that segregation can be very persistent in the long turn (Krysan & Crowder, 2017), thereby challenging

current integration policies. Studies which have been conducted in Asia (Tan, Chai & Chen, 2019; Zhang et al, 2019; Yip, Forrest, & Xian, 2016; Xu et al, 2019) have concluded that policies which address only one part of the activity space, such as mixing housing policies, may have little effect on increasing real social interaction or contacts between different social groups because the majority of socialising takes place outside the residential place and neighbourhood (Yip, Forrest, & Xian, 2016).

From the general viewpoint of society, segregation is considered as being somewhat problematic because it is related to various socio-economic problems such as social exclusion and separation, inequalities in the labour and property markets, living environments, education, and differences in media consumption (Bolt, Özüekren, & Phillips, 2010; Wong & Shaw, 2011; Vihalemm, Juzefovičs, & Leppik, 2019), which feeds into different spheres in society such as tourism, and urban and regional planning. The impact of migration and segregation also spills over nation-state borders, an aspect that has been little-studied in contemporary segregation research. The increasing ethno-cultural diversity of the destination country leads to more intensive short-term and temporary cross-border mobility between the country of origin and destination. This is partially a good opportunity to develop the country's tourism sector – travel in order to visit family and friends accounts for roughly a third of total visits (Backer, 2012) – but it can also create favourable opportunities in which to continue chain migration (Feng & Page, 2000), which may further deepen social problems.

In order to delve into the spatial comprehensiveness and complexity of segregation process, various datasets and research methodologies are necessary. On one hand, traditional datasets such as censuses, registries, surveys, and interviews are well-suited when it comes to capturing long-term changes in segregation patterns, or to explore separate parts of the activity space and to uncover causal mechanisms. On the other hand, it is very difficult to cover the whole of the human activity space and short-term changes in segregation with these datasets. Empirical studies using new data sources such as mobile positioning data and social media information have spurred on theoretical advancements in segregation research by providing individual-level data which usually covers a large part of the human activity space, a necessity when it comes to understanding the vicious circles of segregation and in finding ways in which these circles can be broken. New data sources have also been subjected to scientific debate in terms of the usefulness of such data sources and how the assets of both streams of data can be combined (Wang et al, 2018).

Mobile phone data is one specific data source which captures an extensive part of the human activity space. Nowadays, mobile phones are highly important to most people for their everyday communications, along with management processes, work, and information searches. As a result, most people carry them on an everyday basis, which makes mobile phones valuable sensors that can capture people's everyday whereabouts either actively or passively. The first indicates a situation in which an application is saved to a person's mobile phone that collects mobility data using a GPS device. The latter indicates a situation in which

approximate spatial locations within the bounds of accuracy levels of antennae coverage are saved in the mobile phone operator's databases whenever a person carries out a call activity. Both datasets provide high spatio-temporal resolution data on the spatial mobility of individuals and their activities which cannot be otherwise captured. Using mobile phone data enables researchers not only to have a better picture of the whole activity space but also to introduce the dynamic aspect of segregation. These are also the key characteristics of activity space segregation (Zhang et al, 2019).

The aim of this dissertation is to better understand activity space segregation by exploring the relationship between ethno-linguistic background, activity space, and social networks. Passive mobile positioning data is used to study the activity-space segregation of the Estonian-speaking majority and the Russian-speaking minority within the time period of 2007–2016. The study area is Estonia, and outbound trips abroad are also observed. In order to reach the specified aim, more precise **research questions** are as follows:

1. Which ethno-linguistic differences occur in activity spaces in Estonia and abroad? (Articles I, II, III, IV.)
2. How does activity space segregation vary across age groups and generations? (Articles II, III.)
3. How does the level of ethnic segregation vary in time? (Article I.)
4. What is the relationship between social networks and the activity spaces of ethno-linguistic groups? (Articles I, II, III, IV.)
5. How do residence and workplace affect activity space and the ethno-linguistic composition of social networks? (Articles III, IV.)

This thesis contributes to existing activity space segregation studies by observing the activity spaces and mobility of Estonian and Russian-speaking populations in Estonia and abroad. Estonia is a small Northern European country which has faced increasing levels of segregation since the collapse of the Soviet Union (Mägi et al, 2016; Musterd et al, 2017). Estonian and Russian-speaking populations tend to live and move around in parallel societies, something that is a problem which is even acknowledged by Estonian politicians. For this reason, research on such social issues is a necessity. This thesis is organised as follows: in the theoretical section the concept of the activity space is first introduced, followed by its application in segregation studies. New approaches in terms of explaining the persistence of segregation are then discussed, and then an overview is provided of how activity space segregation has been measured. As this thesis employs passive mobile phone data, this data is introduced in the methods section, and an overview is provided of the approach being used in terms of methods and analysis. The results section is organised in accordance with research questions, representing a synthesis of the results from publications. The final part of the thesis is dedicated towards discussing the results in light of earlier research, and in offering possible explanations and future directions in segregation research. The contribution of this thesis to segregation research is outlined in the discussion section.

2. THEORETICAL FRAMEWORK

2.1 An individual's activity locations and mobility: the concept of activity space

The notion of activity space is rooted in behavioural and time geography from the 1970s, when the spatio-temporal dimension of human activities became the core focus of mobility research (Golledge & Stimson, 1997; Hägerstrand, 1970; Patterson & Farber, 2015). At the beginning there were a good many similar terms being used in parallel which referred to a spatial area inside a bigger spatial unit, one which the person is either 'aware of' ('awareness space' by Brown & Moore, 1970; Patterson & Farber, 2015), or with which one has direct contact ('action space' by Horton & Reynolds, 1970; Patterson & Farber, 2015). Later, the initial individual-based notion has been further developed by a number of scholars. The three most notable are Dijst and his work on three types of action space (1999), and Colledge and Stimson who proposed the term 'activity space' (1997). Dijst (1999) differentiated between three possible spatial areas which are related to a specific individual and that individual's activities, knowledge, opportunities, and behaviour. Firstly, the perceived action space refers to all locations of which the individual is aware. Secondly, the potential action space refers to a spatial area within which an individual's possible activity locations can lie, which is very closely linked to the accessibility concept. Thirdly, actual action space refers to the area which consists of places that the individual has actually visited. The latter coincides with the activity space that is discussed by Golledge and Stimson (1997), which consists of visited activity locations and any travelling around and between those sites (Schönfelder & Axhausen, 2003). Activity space is, therefore, a measure of an individual's actual spatial behaviour (Perchoux et al, 2013). Activity space is now a very common starting point for studies in human mobility, travel, transportation, and segregation (eg. Howell et al, 2017; Järv, Ahas, & Witlox, 2014; Järv et al, 2015; Xu et al, 2016), partially because the development of ICT-based data collection techniques make it possible to precisely observe human spatial behaviour and places that have been visited.

Human activity space consists of different activity places, ie. meaningful 'anchor points' around which everyday life is organised (Ahas et al, 2010; Golledge & Stimson, 1997; Järv et al, 2014). The main components of activity space are residential place, regularly visited daily activity sites such as work, shops, training areas, and the movement around these sites (Figure 1; Golledge & Stimson, 1997; Schönfelder & Axhausen, 2003). Ahas and others (2010) stress that, besides residential place, the workplace also represents an important focus for everyday movement. Similarly, Schlich and others (2004) bring forward leisure activities because these play an increasingly important role in everyday life and related travel. This implies that activity spaces are in essence multi-centred (Perchoux et al, 2013; Raanan & Shoval, 2014; Li & Tong, 2016). Nevertheless, residential place usually exists for a majority of people, and its location usually changes less

frequently when compared to workplace and leisure activity locations. The importance of residential place has become especially relevant during the COVID-19 pandemic, when many had to relocate their various activities (work, leisure, and shopping) into the home.

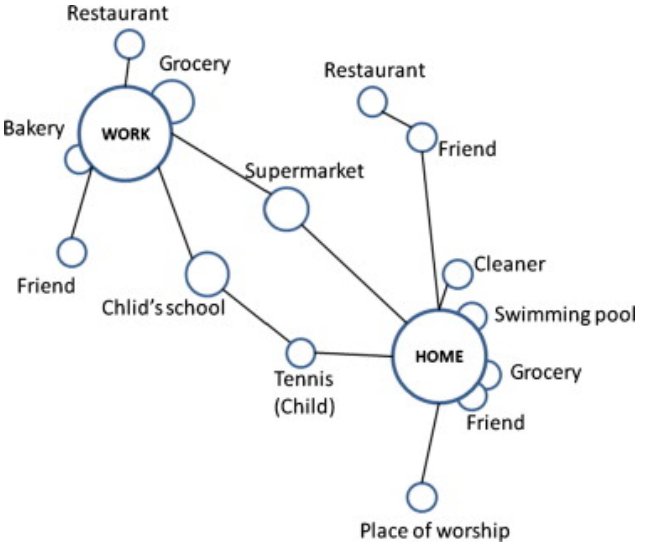

Figure 1. The individual's activity space. Source: Perchoux et al (2013).

While the notion of activity space is relatively fixed, the way in which the concept may be actioned is not. Patterson and Farber (2015) have written a great overview on different methodological approaches in regard to how activity space has been represented and measured. The most common starting point are geometric shapes. Standard deviational ellipses and circles, ellipse-like forms (such as a super-ellipse, a Cassini oval, or a Bean curve), and minimum convex polygons serve to describe the spatial dispersion of activity locations (Järv et al, 2014; Li & Tong, 2016; Patterson & Farber, 2015; Rai et al, 2007). A network-based approach is based on the notion that people's spatial behaviour is constrained by the transportation network (Patterson & Farber, 2015). One example of this is the process of constructing buffers around the shortest paths between locations (Schönfelder & Axhausen, 2002; 2003), and network-based ellipses (Li & Tong, 2016). Furthermore, kernel densities interpolate points into a continuous surface and thereby combine actual visited places and visitation frequencies (Patterson & Farber, 2015; Schönfelder & Axhausen, 2002). While geometric shapes, networks, and surfaces also contain places which are not actually visited by an individual, the 'activity locations' approach only takes into account places that have actually been visited. One sample measure for this approach is the number of unique locations that have been visited, something that is used to represent the size and diversity of activity spaces (eg. Kamruzzaman et al, 2011; Silm & Ahas, 2014a; Patterson

& Farber, 2015; Li & Wang, 2017; Masso, Silm & Ahas, 2019; Wang, Li & Chai, 2012).

While the spatial dimension of the activity space concept has received a good deal of attention in geographical and transportation research, the temporal dimension has not been quite so explicitly clarified (Wong & Shaw, 2011). The temporal dimension of the activity space implies the timeframe in which human activities occur, but also how long the activities take place (duration), how often they occur (frequency), and how regularly different locations are visited (Perchoux et al, 2013). Golledge and Stimson (1997) originally refer to an activity space which contains daily activities, their locations, and in-between mobility. Obligatory activities (work and school) and maintenance activities (household) have a routine daily and weekly pattern (Golledge & Stimson, 1997; Järv et al, 2014), but free-time or leisure time activities on the other hand are more sporadic and depend upon personal preference, opportunities, traffic, weather, and other factors (Schlich et al, 2004). In order to capture the whole human activity space, it is necessary to track human spatial behaviour over a longer period of time, as has been done by Järv and others (2014), which increases the probability of irregular activities and timeframes also being included.

One form of irregular activity which is related to leisure time is the celebration of special occasions like holidays and festivals. In **Article I** holidays have been discussed in relation to activity space, but also in relation to ethnic background which serves to influence those activities that are undertaken during that period of time. As holidays are first hand instruments for producing shared memories and values through collective celebrations, commemorations, and recreational events (Zhu, 2012), this is the timeframe in which various forms of activity will occur. When holidays are accompanied with free time it provides people with opportunities to reunite with family and friends, or to perform cultural or religious activities (Wallendorf & Arnould, 1991) which are reflected in travel behaviour. When compared with more everyday timeframes, during special occasions people tend to travel longer distances (Cools, Moons, & Wets, 2007), and certain holidays can display temporary large-scale population migration (Pan & Lai, 2019), such as Thanksgiving Day in the US or the Chinese New Year in China.

Different activity places and neighbourhoods are connected via travel or commuting (van Kempen & Wissink, 2014). Spatial mobility enables people to be exposed to other people, social encounters, and physical environments which are different from their everyday routines (Wang & Li, 2016). In fact, prior to the arrival of COVID-19 and its related mobility restrictions, travel volumes and the spatial mobility of people were gradually increasing, placing mobility at the heart of the functioning of contemporary societies (Cresswell, 2011). It has previously been stated quite effectively that, in today's mobile society, connectivity often matters more than physical proximity (Wissink, Schwanen, & van Kempen, 2016). The new mobilities paradigm highlights a shift in mobilities research which serves to stress the need to neglect spatial fixity and focus on how new meanings, sociality, and identity are created through mobility (Sheller & Urry, 2006). Even though this had already been proposed as far back as 2006, the new mobilities

paradigm also drew attention to the growing figures in terms of the cross-border mobility of people and material objects. Recently (prior to the start of the COVID-19 pandemic), the figures for migrants and tourists were gradually increasing (International Organization for Migration, 2019; UNWTO, 2020). This indicates that a growing number of people frequently cross nation state borders and that people's true activity space can span multiple countries.

Those research fields which explicitly deal with temporary cross-border human mobility are tourism and transnationalism studies. Permanent cross-border mobility and the resultant social processes have mainly been tackled in migration studies. While tourism research deals (in very broad terms) with different aspects of travel-related consumption and involves a large number of people, transnationalism studies focus on the lifestyle practices of the few who are connected to many countries at once. Transnational human activities imply those practices which take place beyond nation state borders and which entail social, economic, and political cross-border networks (Deutschmann, 2016). Activities that have been considered as being transnational entail frequent ties with and connections to different countries. These are activities that involve either physical mobility such as living, working, or studying abroad for a certain period of time, frequent travel to a country of origin for visiting friends and family, or for spending holiday time, or economic and political activities such as sending remittances, migrant voting in their home country, regularly following the news from another country, and owning a property abroad (Delhey, Deutschmann, & Cirlanaru, 2015; Waldinger, 2008). It has previously been stated that remaining closely tied to many countries at once – in the form of a transnational lifestyle – can represent a new form of contemporary migration (Portes, Guarnizo, & Landolt, 1999; Vacca et al, 2018). Resulting temporary mobility patterns (ie. job-related commuting) and activity locations (ie. shopping abroad) which are situated in foreign countries are definitely part of the human activity space, but so far studies which cover activity space have not incorporated cross-border mobility or considered human action within a single country alone. For this reason, in **Article III**, the concept of the activity space has been extended to 'transnational activity space' to account for the true extent of human activity spaces (Figure 2). As spatial mobility is highly dependent upon geographical distance, the impact of distance in transnationalism studies is not particularly well conceptualised (O'Connor, 2010), because the propensity to travel is not linearly associated with distance. When Deutschmann (2016) states that most transnational activities happen over short distances, various case studies on diasporas and postcolonial settings also indicate strong transnational ties over long distances (eg. O'Connor, 2010), which are important when it comes to understanding of the functioning of ethnic communities.

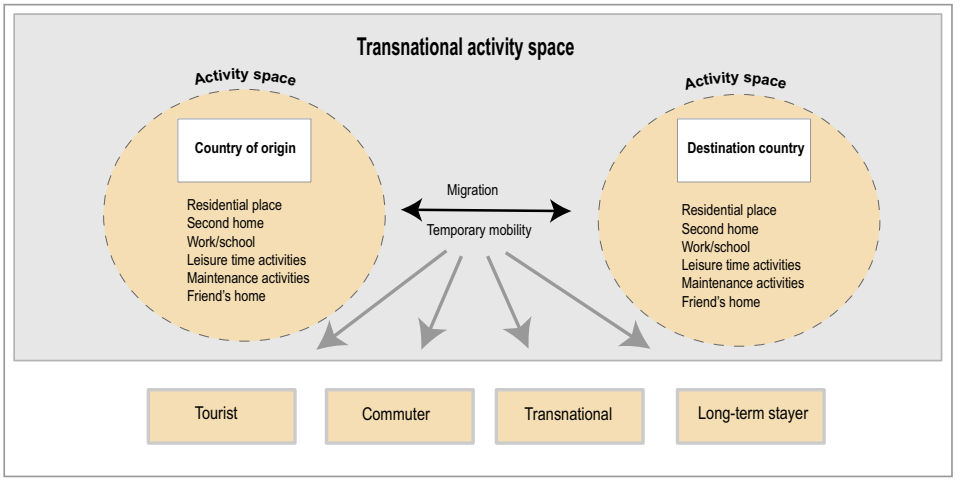

Figure 2. The transnational activity space, which covers different areas of connectivity between activity spaces that are located in different countries. Based on different variables (eg. the frequency of visits and time spent in countries), different visitor groups can be distinguished such as tourists, commuters, transnationals, and long-term stayers. Source: **Article III**, Figure 2 (modified).

2.2 Activity space segregation

Different settlement trajectories and outcomes take place due to physical cross-border mobility: migration. Upon arrival in a new country, a migrant faces challenges in terms of socio-economic and cultural adaptation. Due to various and overlapping factors which are related to individual choice and structural barriers, a migrant can end up living in a residentially segregated neighbourhood. Spatial separation of activity locations between minority and majority population groups indicate spatial segregation, which is often seen as opposing assimilation and integration (Bolt, Özüekren, & Phillips, 2010).

The process of separation and its dimensions have been thoroughly examined, mainly from the perspective of the main anchor point of human activity space: residential place (see, for example, Bolt et al, 2010; Duncan & Duncan, 1955; Johnston, Poulsen, & Forrest, 2007; Krysan & Crowder, 2017; Massey & Denton, 1988). Residential segregation exists when one population group is concentrated within specific parts of the spatial area while uniform distribution indicates the lack of segregation. Residential segregation has traditionally been measured with indices which describe the degree of uneven distribution, exposure, concentration, and clustering for some particular spatial area (Massey & Denton, 1988). However, such a place-based approach does not provide any detail about how living in an ethnic enclave may affect an individual's opportunities and future prospects in other life spheres (Jones & Pebley, 2014; Schnell & Yoav, 2001; Wong & Shaw, 2011).

The concept of an activity space which incorporates the individual and their activity places complements the shortcomings of the (residential) place-based segregation approach. Activity space research has not only provided new analytical tools for segregation scholars, it has also affected the entire understanding of segregation. Activity space segregation implies that members of various ethnic groups may come into contact with fundamentally different neighbourhoods and activity locations throughout their daily life, and that they therefore operate in separated geographic spaces (Krysan & Crowder, 2017). Three main attributes of activity space segregation can be outlined: firstly, the shift from a place-based approach to a people-based approach (Järv et al, 2015; Schnell & Yoav, 2001; Wong & Shaw, 2011); secondly, the shift from residential place to whole activity space (Wong & Shaw, 2011; Silm & Ahas, 2014a; Wang & Li, 2016; van Ham & Tammaru, 2016); and thirdly, the incorporation of the temporal dimension (Silm & Ahas, 2014b; Tan, Kwan & Chai, 2017; Park & Kwan, 2018; Zhang et al, 2019; Hong, 2020). The idea that people can experience segregation in various socio-spatial settings, locations, timeframes, and life domains, has induced a shift in segregation research, in which single site studies have been replaced by multi-site studies. The emergence of new individual-based data sources (such as those of mobile phones, GPS, social media, and smart card data) have made it possible to place into focus the individual in terms of segregation research, and to allow an examination of other parts of one's activity space besides residence, such as workplaces, schools, leisure time, and mobility, as well as the human activity space as a whole.

Activity space segregation research has proven that segregation is evident, and that it can also be experienced in other parts of the human activity space (Wong & Shaw, 2011; Farber, Páez & Morency, 2012; Wang, Li & Chai, 2012; Kwan, 2013; Silm & Ahas, 2014a; Järv et al, 2015; Toomet et al, 2015; van Ham & Tammaru, 2016; Shen, 2019; Xu et al, 2019). What is more, Jones and Pebley (2014) showed that the social landscape to which individuals are exposed in their whole activity spaces is very much different from the social characteristics of their home neighbourhood. This indicates that placing consideration on residential places alone may not adequately represent the social environment through which people move on an everyday basis (Jones & Pebley, 2014). Multi-site studies from various countries indicate that segregation is predominantly at its highest in people's places of residence, while it tends to be lower in workplaces and is diverse in free time and recreation activities (Strömgren et al, 2014; Toomet et al, 2015; Hall, Iceland & Yi, 2019). There are also studies which measure segregation across the whole activity space (eg. Järv et al, 2015; Toomet et al, 2015; Xu et al, 2019). Segregation studies from Estonia have concluded that the extent of the activity space for minorities tends to be smaller than that of the majority (Silm & Ahas, 2014; Järv et al, 2015, 2020), but a study from Los Angeles stated that African-Americans have larger activity spaces than do Whites or Latinos (Jones & Pebley, 2014). This leads to the question of what the size of the activity space actually represents. A common assumption in segregation literature is that smaller activity spaces are related to social exclusion and limited spatial mobility, but this is not

universal as it depends upon the urban context and may not necessarily imply disadvantage (Patterson & Farber, 2015). Living in a well-connected city centre may result in smaller activity spaces, whilst residing in the outskirts of a city may increase daily spatial mobility and activity space. Despite this, fundamental differences in the activity spaces of social groups imply different life course prospects (Krysan & Crowder, 2017), and smaller inter-group interaction potential, whilst an overlap in activity spaces can indicate the opposite (Park et al, 2021).

Spatial mobility is the means by which different parts of the activity space can be connected, thereby creating exposure to opportunities, structures, cultures, countries, and people (Cook & Butz, 2019; Krysan & Crowder, 2017). A new study into this matter by Park and others (2021) showed that people are not 'locked into socioeconomic bubbles' while they move (p 8). As the mobility paradigm puts it, mobility is one of the cornerstones of modern society. Therefore having mobility capital seems to be a prerequisite for success and a route for exiting any marginal position within society (Benz, 2019; Cass & Manderscheid, 2019). For example, cross-border job-related commuting helps individuals to earn a higher salary, which in turn helps them to invest in housing in their own homeland and to reduce inequalities (Anniste & Tammaru, 2014). High spatial mobility has, however, dual implications. On one hand it can reflect an ability to conduct activities in different locations, but on the other hand it can reflect a 'must move' desire in order to satisfy one's own needs (Patterson & Farber, 2015; Susilo & Kitamura, 2005). Therefore spatial mobility can be closely tied with opportunities, but at the same time it can also be tied with social exclusion and, through (im)mobility inequalities, can be transmitted in terms of space. Mobility as a mechanism for recreating inequalities (Krysan & Crowder, 2017) or exiting from inequalities has been further developed in the mobility justice theory (Sheller, 2019). It has been aptly stressed that the constant increase in the spatial mobility of people can result in a displacement of inequalities from one country to another due to the environmental and socio-economic consequences of increasing global mobility (Cass & Manderscheid, 2019; Sheller, 2019).

2.3 Circles and drivers of segregation

Even though the root causes (history, political decisions) of segregation are different in various countries, three main explanations have been offered in order to be able to provide an answer to the question of why segregation occurs and persists. These three explanations are preferences, socio-economic marginality, and discrimination (Johnston, Poulsen, & Forrest, 2006; Krysan & Crowder, 2017). These core factors have mainly been applied to explain residential segregation, but the same set has been also employed to discuss segregation which occurs in different parts of the activity space. What is important to note, however, is that these drivers have mainly been considered as mutually exclusive, and that they even compete against one another in segregation literature. But this viewpoint may not be accurate because they operate in complex and overlapping

ways, and the interaction between causal factors is equally important in understanding the (re)production of segregation (Krysan & Crowder, 2017). The new emerging theory of segregation circles (van Ham et al, 2018) or cycles (Krysan & Crowder, 2017) attempts to introduce new areas of explanation into resolving the question of why segregation is so persistent over time. The main idea of segregation circles is that different domains and activity locations are interlinked, and segregation is transmitted from one activity place and life domain to another due to complex and overlapping causal factors. However, at what stage and exactly how these drivers come into play is an area that so far has received notably insufficient study. Krysan & Crowder (2017) have revised the theory of residential segregation and have provided a theoretical model of how the process works (Figure 3). It has to be noted that even though the theory mainly serves to explain the persistence of residential segregation, the authors see the whole human activity space as being important, and refer to the interconnectedness of various activity sites. According to their model, the 'selection' of residential place is not actually a rational choice but rather the result of an elimination process with different stages. Since people never have the complete picture of available options, they rely heavily on their personal biographies, their everyday life activities and experiences, and information from social networks, the media, and property agents. As a consequence of several factors, people either start eliminating neighbourhoods and units which, for one reason or another, are not appropriate, or such neighbourhoods and units are being eliminated for them. When social groups have very different activity spaces, their preliminary knowledge base in terms of available neighbourhoods, and therefore their initial perceived 'choice set', is already fundamentally different and does not overlap, which essentially prohibits spatial assimilation and reproduces segregation.

Such radical differences in the residential space feed into other activity places too, forming a causally related circle in which inequalities are transmitted from one place or domain to another (Krysan & Crowder, 2017; van Ham et al., 2018). For example, occupying a marginal position in society due to a lower income or discrimination can lead to fewer opportunities in the labour and housing markets (Allen & Turner, 2012), as well as smaller social capital (Heizmann & Böhnke, 2016), and poor accessibility to mobility and services. It has been shown elsewhere that residents from poor neighbourhoods tend to carry out their everyday activities in other poor neighbourhoods (Yip, Forrest, & Xian, 2016) and that they are, therefore, more likely to be exposed to people of a similar socio-economic background (Wang & Li, 2016). The latest studies from Asia (Yip, Forrest, & Xian, 2016; Tan, Chai & Chen, 2019; Xu et al, 2019; Zhang et al, 2019) show that common integration policies which address residential place (eg. mixing housing policies) have little effect on increasing the social capital of differing social groups because the majority of socialising takes place outside one's residential neighbourhood (Yip, Forrest, & Xian, 2016). Exposure to other poor neighbourhoods and people shapes the knowledge base of an individual which affects the choice of where to live, work, or spend one's free time (Krysan & Crowder, 2017; van Ham et al, 2018; Kukk, van Ham & Tammaru, 2019), thereby forming segregation circles.

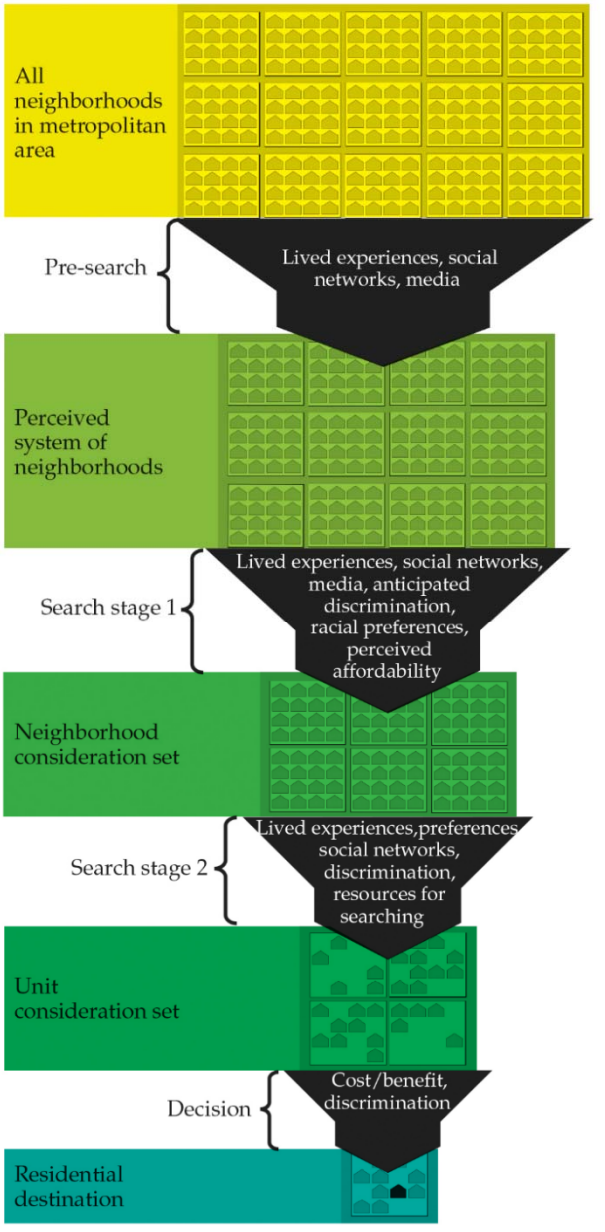

Figure 3. The housing search process and influencing factors in various stages of the process. Source: Krysan and Crowder (2017, p 53).

Such vicious circles of segregation can appear due to a good many, often overlapping, causal factors such as history, policies, discrimination, preferences, or resources on the one hand, but also due to lived experiences and social networks on the other (Krysan & Crowder, 2017; van Ham et al., 2018). The traditional approach when it comes to discussing the role of preferences in various activity locations and residential choices is as follows: different ethno-linguistic groups end up living near others of their own group, spending their free time in specific locations due to their preferences, group-specific values, norms, and behaviours (Schelling, 1971; Musterd & van Kempen, 2009; Allen & Turner, 2012). Preferences can, however, indicate a very diverse set of motivations which, in addition to containing a wish to preserve an ethnic community, can also cover fear and hostility (Kaplan & Woodhouse, 2004). In terms of residential place, preferences can also occur when assessing the comfort, familiarity, and safety of a certain residential option, and this may operate in different ways for an ethnic minority (in terms of spatial preference) than it does for the dominant group (in terms of spatial avoidance).

However, not all preferences are realised (see Krysan & Crowder 2017), which indicates the effect of other factors. Socio-economic marginality refers to differences in income and education which can be translated into people's mobility, activity locations, and residential opportunities. This means that disadvantaged groups sort themselves into poorer neighbourhoods because they cannot afford residential units in more affluent neighbourhoods (Musterd & van Kempen, 2009), or costly leisure time activities (Stodolska, 1998), and that they have different jobs and workplaces (Strömgren et al., 2014), or that their accessibility to mobility options is limited (Kamruzzaman & Hine, 2012). According to the revised model by Krysan and Crowder (2017), the influence of resources in terms of selecting a residential neighbourhood is not as straightforward as has so far been considered. In fact, based on affordability and perceived (!) affordability, several neighbourhoods are eliminated at the very beginning, even when it is the case that within those spatial areas there can actually exist affordable residential units. Perceived affordability depends largely on the information that is gathered from official websites, media sources, or social networks. Therefore segregation cannot be explained by differences in resources alone. One example of this is that poor white people still tend to end up living in white neighbourhoods, which indicates the complex role of a good many factors (Krysan & Crowder, 2017). Discrimination accounts for a set of factors that restrict residential choices and other activity locations for some people. These include, for example, discriminatory lending practices and predatory loans, racial steering, prejudice, a geographic concentration of subsidised housing, and other contributing areas (Krysan & Crowder, 2017). Even though direct discrimination is nowadays illegal, it appears in more indirect ways such as racial steering, where property agents offer neighbourhoods and units depending on their own perceived financial capability of a home-seeker (Krysan & Crowder, 2017).

The segregation process is largely affected and formed by personal social networks: specifically by their structure, in terms of size, shape, density, centrality

(Verdier & Zenou, 2017), and composition, ie. the proportion of members with similar and different characteristics (Bojanowski & Corten, 2014). The tendency to build relationships with others who are similar to ourselves (homophily) is well known (McPherson, Smith-Lovin, & Cook, 2001), and is an important driver of segregation. Social networks are the source of information and social support for minority group members (Krysan & Crowder, 2017), and the information that flows though social networks is dependent upon its composition and structure (Verdier & Zenou, 2017). Personal social networks can be divided into closed (co-ethnic, homophilous) (Portes, 1998) and open (inter-ethnic, bridging) (DiPrete et al, 2011). Inter-ethnic networks are believed to contain a greater variety of resources and information on opportunities in the residential and labour market (Marques, 2012; Peters, Finney & Kapadia, 2019), and studies have shown that balanced levels of contacts with natives and co-ethnics in a migrant's social network is associated with a higher level of economic and cultural assimilation (Vacca et al., 2018). The formation of inter-ethnic ties depends upon the presence of common interests and/or concerns, an adequate level of trust, and language proficiency (Grossetti, 2005; Heizmann & Böhnke, 2016). Since people often want to live near their family or friends, social ties influence the choice set of residential options and the perpetuation of segregation (Krysan & Crowder, 2017). In addition, the act of visiting members of social networks helps one to discover new places and to complete the knowledge base of possible activity options in neighbourhoods that are outside of their own. Social networks are also formed in different activity locations (ie. segregation can create community-based and closed networks), so there also exists a multidirectional relationship between activity space and the formation of social networks (Galster, 2019; Figure 4). In addition, social ties extend state borders, which influences cross-border mobility. Emigrants' transnational lifestyles have also been partially examined in tourism studies, mainly under the keywords of visiting friends and family (VFR tourism), return visits, diaspora tourism, ethnic tourism, roots tourism, genealogical tourism, or ethnic reunions (Fourie & Santana-Gallego, 2013; Li & McKercher, 2016). These studies have been seeking out the connections between tourism, migration, and social networks, and have concluded that tourism and migration are interrelated processes which operating in both directions: short-term cross-border travel such as tourism can generate migration and *vice versa*, mainly due to the expanding geography of social networks (Feng & Page, 2000; Larsen, Axhausen & Urry, 2006; Dwyer et al, 2014).

The factor of lived experiences is one thing which can affect the perpetuation of segregation, something that is highly related to a person's activity space (Krysan & Crowder, 2017). Lived experiences form through everyday activities and mobility, such as driving through certain neighbourhoods, casual interactions with strangers, seeing advertisements, etc, which affect the knowledge base and perceptions of new environments, while providing exposure to those new environments. When a person experiences segregation in multiple activity places, this in turn produces a disproportionate knowledge of opportunities (Krysan & Crowder, 2017).

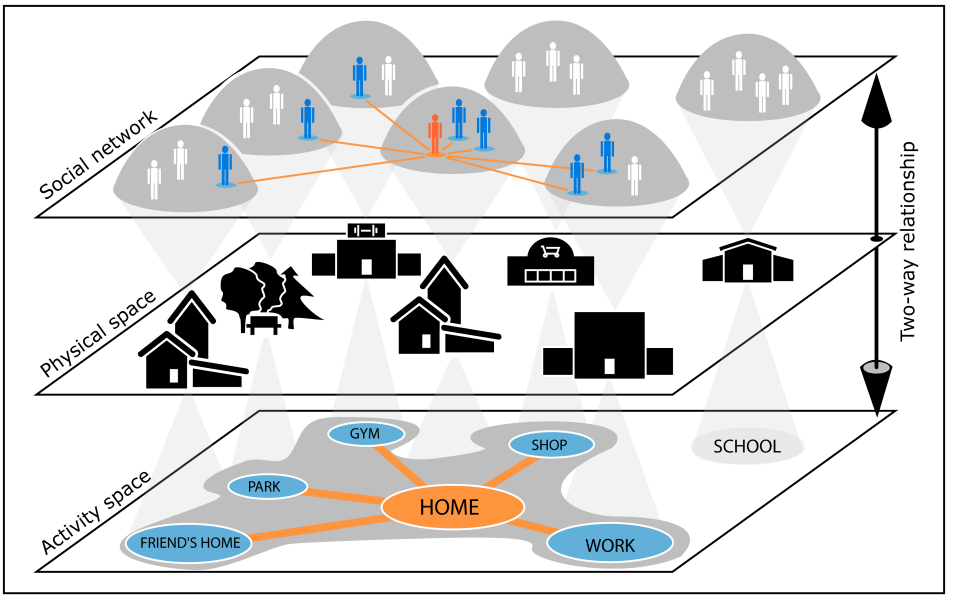

Figure 4. An individual's activity space and social network. Source: **Article IV** Figure 1.

2.4 Methods for measuring activity space segregation

Activity space segregation studies have applied both traditional and new data sources. Examples of traditional datasets include travel surveys or diaries (Hong, 2020; Le Roux, Vallée, & Commenges, 2017; Park & Kwan, 2018; Tan et al, 2019, 2017; Wang & Li, 2016; Wang et al, 2012) and census information (Shen, 2019). Examples of newer data sources include mobile phone Call Detail Records (Järv et al., 2020, 2015; Silm & Ahas, 2014a, 2014b; Toomet et al., 2015; Xu et al., 2019), signalling data (Park et al, 2021), GPS data (Raanan & Shoval, 2014; Yip, Forrest, & Xian, 2016; Shdema, Abu-Rayya, & Schnell, 2019; Zhang et al, 2019), and social media data (Qiao et al., 2021).

Traditional measures of segregation include place-based segregation indices. In their seminal work, Massey and Denton (1988) differentiated between five dimensions of segregation: evenness, clustering, concentration, exposure, and centralization, along with providing related indices, out of which the formation of the dissimilarity index has been one of the most widely-applied measures when it comes to characterising the residential (un)evenness of various ethnic groups. Traditional segregation indices are, however, aspatial, meaning that they do not adequately account for spatial relationships and topology (Brown & Chung, 2006; Reardon & O'Sullivan, 2004). For this reason, many segregation scholars have tried to update the indices by incorporating the spatial dimension into the indices (eg. Wong, 2003), which results in computationally quite heavy calculations and a more complicated interpretation. LISA statistics such as Moran's I

and Getis and Ord's G* have also been applied for measuring residential segregation (Johnston, Poulsen, & Forrest, 2011).

There are innovations in the traditional measure of segregation indices which try to incorporate the principles of activity space (in terms of individual-based activity space, time activity space, and whole activity space). Xu and others (2019) have proposed interesting indices of communication and physical segregation which draw on the individual-based approach in terms of activity space segregation. The individual communication segregation index describes the homophily of social networks. The physical segregation index takes into account all three underlying principles of activity space segregation. This differs from traditional place-based measures by the fact that it is calculated for individuals and for all activity locations across hours. The index will provide information on pairwise co-location probabilities for all of those people who have been included. Somewhat similarly, the co-presence index reveals the probability of a randomly-chosen member of group 'X' perhaps sharing the same spatial unit with a member of group 'Y' (Le Roux et al., 2017; Toomet et al., 2015). The individual segregation index has been also proposed by Park & Kwan (2018).

Even though traditional index-based measures are also used in activity space segregation studies (eg. Silm & Ahas, 2014b), newer methods which have been borrowed from activity space research have also been applied, and definition has also been provided for the related segregation dimensions concept. Wang and others (2012) suggested different dimensions along which activity space segregation can occur and be measured. Firstly, **extensity** reflects the spatial dispersion of activities and mobility. This dimension is closely linked to reaching opportunities and achieving accessibility. When it comes to describing the extent of activity spaces, standard deviational ellipses (Järv et al., 2020, 2015), buffers (Zhang et al, 2019), geographical distances (Wang & Li, 2016), and minimum convex polygons (Jones & Pebley, 2014) have all been used. Secondly, **intensity** reflects the temporal dimension by indicating the frequency and duration of visits and activities. This can reflect the significance of particular activity locations or mobility in one's life. This dimension has been measured and visualised with activity (kernel) density surfaces (Wang, Li & Chai, 2012; Tan, Chai & Chen, 2019; Zhang et al, 2019), along with activity durations, and travel frequencies or travel duration (Yip, Forrest, & Xian, 2016; Tan, Kwan & Chai, 2017; Shdema, Abu-Rayya, and Schnell, 2019; Zhang et al, 2019). Thirdly, **diversity** indicates the number of locations within the activity space which reflects the richness of spatial behaviour. This has been applied by Wang and Li (2016) and Zhang and others (2019). Fourthly, **exclusivity** represents the degree of isolation across transportation modes and activity sites. Zhang and others (2019) calculated the percentages of activity time spent in public spaces and the percentages of travel time spent on public transportation. This list was later complemented by a fifth dimension, that of **social exposure/isolation** (Wang & Li, 2016). This dimension reflects the presence of other social groups in one's activity space. Higher proportions of the other socio-demographic groups increase the likelihood of inter-group social interaction and smaller social isolation. In order to be able to measure

this dimension, ancillary datasets are often used. A common data source for this dimension is population census data which describes the composition of certain spatial areas based on the residential population of those areas (eg. Silm & Ahas, 2014a; Wang & Li, 2016; Shdema, Abu-Rayya & Schnell, 2019). Yip and others (2016) measured the percentage of activities that were spent in different urban neighbourhood types (eg. poor, rich, middle class, etc). The use of ancillary datasets indicates that despite the emergence of new data sources which contain information on an individual's space-time behaviour, traditional data sources which are rich in variables still provide highly valuable information on the processes. Therefore these data sources should not be taken as opposing one another, but rather as complementing each other.

As mobility connects places and creates exposure to people, social environments, and neighbourhoods which may be different from the usual, it is also an important dimension for the segregation process. The first attempts to measure segregation in mobility have already been made. Shen (Shen, 2019) proposes a flow-based spatial interaction model, one which measures exposure during travelling. Origin-destination data matrices are used as an input, and the results show the dynamic variation in urban flow linkages. Similarly, Park and others (2021) also developed a flow-based spatial interaction model, and compared the impact of geographical and socio-economic distance on mobility flows.

2.5 Integration

The settlement process for ethnic groups is a dynamic one which is influenced by a good many factors, as is covered in Chapter 2.3. Through such settlement process individuals take up over time the cultural, social, and economic attributes of the host group (Massey, 1985). Two main terms when it comes to describing the process of becoming engaged with the host society are 'assimilation' and 'integration'. According to Bolt and others (2010), the term 'integration' is more commonly used in the European context, while in the American context 'assimilation' is more prevalent. Quite a number of scholars do not differentiate at all between integration and assimilation, and consider these terms to be synonyms for becoming attached to the host country (Bolt, Özüekren, & Phillips, 2010; Wessel et al, 2017). However, in the field of cross-cultural psychology and sociology, integration and assimilation are different terms, depicting different settlement strategies (Bolt, Özüekren, & Phillips, 2010). Such processes have been described in the seminal work by Berry (1997) which posits four main settlement strategies: assimilation, integration, separation, and marginalisation. These strategies are differentiated by using as a basis how much a person is willing to 'give up' in terms of their own cultural identity in order to be able to build relations with the host society's culture. During the process of integration, migrants preserve some of their cultural traits and become engaged with the host society, but during full assimilation a migrant will lose their connection with their original culture and become assimilated into the host society (Berry, 1997). One of the main weakness

of such models is the way in which this process is modelled: it is seen as a one-way process, and the degree of attachment to the host society depends only upon the migrant (Bolt, Özüekren, & Phillips, 2010). In order to truly be able to enter into a host society (ie. assimilation or integration), a two-way acceptance is required, both from the minority as well as from the majority. In this current thesis, assimilation and integration are, however, used as synonyms.

Indicators of assimilation include language acquisition, a decrease in differences in terms of socio-economic position (education, income, and occupation), intermarriage, and spatial incorporation (Forrest & Kusek, 2016; van Ham & Tammaru, 2011; Waters & Jiménez, 2005). The traditional straight-line assimilation model foresees gradually increasing integration into the host society over generations in terms of norms, values, behaviours, and other characteristics (Gordon, 1964; Massey, 1985; Alba & Nee, 2003) but this has been heavily criticised for being too simplistic and distant from the reality, while also being too Anglocentric. According to this model, first generation migrants who are born in a foreign country are less assimilated when compared to their offspring, the second generation, which has already been born into the host society. In a similar vein, the third generation is even more integrated than its parents (Alba & Nee, 2003), and the once-heterogeneous society becomes an homogeneous 'melting pot' in time. Those who have spent more time in the host society show greater similarities with the majority: each subsequent generation is believed to have higher social and economic status, and to further take up dominant cultural traits and language (Xie & Greenman, 2011). In line with changes in socio-economic position, changes in spatial residential mobility are also expected. Categorising the spatial assimilation model places it into the classic assimilation models, which assume that increased socio-economic capital is converted into living in desirable (white) residential neighbourhoods (Massey, 1985; Krysan & Crowder, 2017).

Since the process in reality is far from being 'linear', Portes and Zhou (1993) proposed a segmented assimilation theory which stems from the fact that assimilation paths can be different for various social groups. They differentiate between three main paths: assimilation into the middle class, ie. linear upward mobility (basically the same as in the classic theory); assimilation into the urban underclass, ie. downward mobility; and the intentional preservation of migrant cultural traits accompanied by economic integration, ie. selective acculturation. Downward mobility happens when the second generation is unable or unwilling to work in similar sectors of the economy as did their parents, but are at the same time excluded from desirable high-salary jobs (Gans, 2009). Selective acculturation means that upgrades in some spheres can be spotted, such as language acquisition and an increase in socio-economic status, while remaining embedded within their ethnic community by, for example, preserving the elements of their own ethnic culture and transnational ties or living in ethnic neighbourhoods (Waters et al, 2010). With regard to spatial residential mobility, the place stratification model draws attention to the barriers that minorities face in the residential market and what can serve to hinder their linear spatial assimilation. These barriers are mostly related to discrimination by property agents, landlords, and financial institutions

which govern access to affluent neighbourhoods, and which often illegally prohibit access by minorities to such neighbourhoods (Bolt, Özüekren, & Phillips, 2010; Krysan & Crowder, 2017).

In addition, the celebration of holidays has also been considered as one indicator for integration (Eshel & Rosenthal-sokolov, 2000). Ethnic minorities consciously choose the celebrations they observe (Fox, 2006). According to the symbolic ethnicity concept (Gans, 1994), migrants use several symbols, one of which can be celebrations, to express and strengthen their identity and connect the migrant diaspora to its origins (Scully, 2012). Similarly, in order to maintain their own identity and heritage, migrants can avoid celebrating the host society's holidays (Fox, 2006), which points to a process of selective acculturation.

Since political discourse often sees spatial segregation in a negative light, various political measures have been employed in order to achieve a greater social mix, such as anti-discrimination policies, language courses, citizenship courses, spatial dispersal and mixing policies, and others. Spatial incorporation policies are believed to lead to a greater level of social mixing, a bridging of social ties, and the spatial mobility of those who are less well-off (Bolt, Özüekren, & Phillips, 2010). However, studies have shown that spatial proximity itself does not lead to greater levels of social ties, since possessing a similar background or shared interests are cornerstones of the formation of social ties (McPherson et al., 2001). As social networks constitute a great social support system for newly arrived migrants and refugees, spatial dispersal policies can actually hamper their chances to form new family-like ties with co-ethnics in their local surroundings, which may in turn affect their life prospects (Bolt et al, 2010; Larsen, 2011).

3. STUDY CONTEXT: ESTONIA

Research in the current thesis has been conducted in Estonia. With a population of 1.3 million, Estonia is a small country in Northern Europe which has a Soviet legacy in terms of both housing and population. According to the last census (2011) Estonians comprise 69% of the population, while the biggest ethnic minority – Russians – forms 25% of the population (Statistics Estonia 2011). This minority population was formed during the Soviet era, when many other nationalities such as Russians, Ukrainians, Byelorussians, and others were brought in from various Soviet Union republics for several reasons. As the main language of communication during the Soviet period was Russian, many ethnic groups which migrated into Estonia spoke – and still speak – the Russian language on an everyday basis. For this reason, speaking the Russian language as a mother tongue has become the most important distinctive feature of the Russian-speaking minority, while also being a component of its identity (Mägi et al, 2020; Vihalemm, 1999). Another distinct feature of the Russian-speaking population is its consumption of Russian media (Vihalemm et al., 2019). From the point of view of immigration, once Estonia had regained its independence in 1991 there were no significant new waves into the country (Kukk, van Ham & Tammaru, 2019). For this reason, Estonia serves as an interesting study case in terms of the segregation and integration processes.

Segregation is a big issue in Estonian society, one which has grown in terms of interest over the last thirty years (Mägi et al., 2016, 2020). The roots of segregation in today's Estonia extend into the Soviet era, and also into its labour market and residential placement policies for immigrants (Kährik & Tammaru, 2010). Large shares of the Estonian and Russian-speaking population live in parallel societies. The socio-economic positions of these ethno-linguistic groups differ significantly: Estonians tend predominantly to work in white-collar occupations while Russian speakers tend to occupy in blue-collar jobs (Saar & Helemäe, 2017; Tammaru & Kulu, 2003). Differences in income extend into the housing market, resulting in even higher residential segregation than workplace segregation (Toomet et al., 2015). Russian speakers are concentrated in the larger cities in northern and eastern Estonia (Figure 5). Besides those socio-economic differences, preferences and social networks also play a role in residential segregation. It has been shown elsewhere that, when changing one's place of residence, Russians tend to move to places which already have a high share of Russians (Mägi et al., 2020). With regard to leisure time activities, this is often considered as being a space which enhances social interaction (Peters & de Haan, 2011). Studies have shown little interaction between Estonians and Russian speakers in certain types of leisure-time activities (Kukk et al., 2019). The education system in Estonia is still linguistically separated (ie. Estonian and Russian-language schools and kindergartens stand side-by-side), something which also affects the formation of social networks. Most inter-ethnic contact between Estonians and Russian speakers occurs in the public sphere (at work, on the street, or on public transport) (Korts, 2009), while family and personal social networks in general remain separated (Vihalemm, 2007).

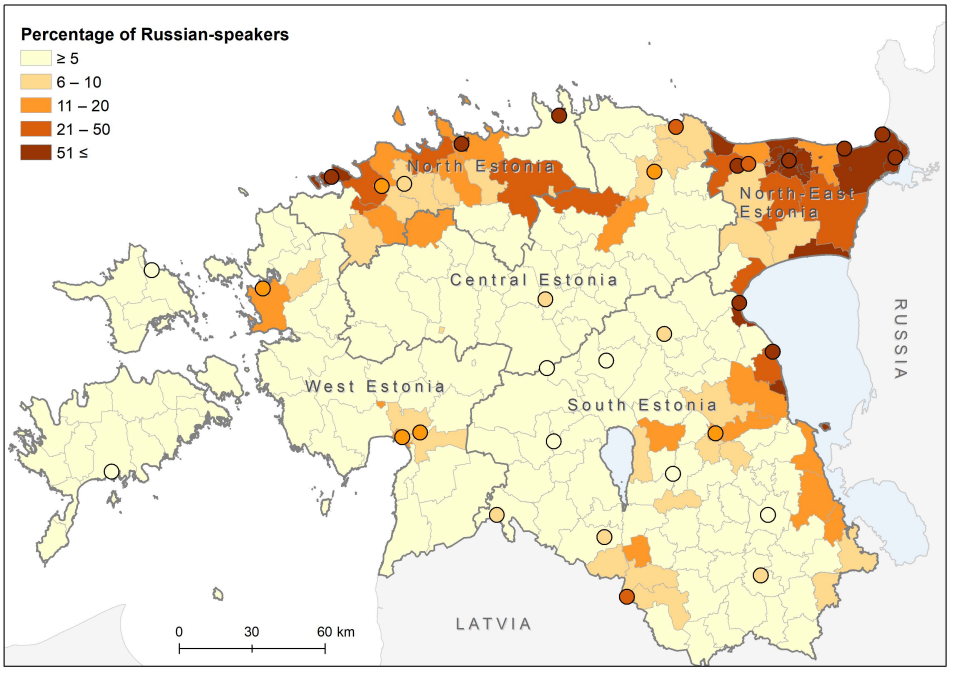

Figure 5. The distribution of the Russian-speaking minority across Estonian municipalities. Source: **Article III** Figure 1 (modified).

With regard to mobility, Russian speakers tend to visit districts which are populated mainly by the Russian-speaking minority (Silm & Ahas, 2014a). Their activity spaces in general are smaller than those of the Estonian-speaking majority (Järv et al., 2015). Not much is known about the cross-border mobility of the two ethno-linguistic groups. Starting from 2004, when Estonia joined the European Union, travel between European countries became much easier. Finland became one of the most important destination countries for Estonians, due to its cultural proximity and its higher standard of living and better salaries. This country now hosts one of the largest Estonian communities in the world (Anniste & Tammaru, 2014). One important structural factor which affects the cross-border mobility both of the Estonian and Russian-speaking population is citizenship and visa requirements. A total of 85% of the population has Estonian citizenship, which permits visa-free travel between European countries, but in order to be able to travel to Russia a visa is required. Just 7% of the Estonian population has Russian citizenship, which permits visa-free travel between Estonia and Russia. Only 6% of the Estonian population have an alien's passport, which allows both visa-free travel to European countries as well as to Russia (Statistics Estonia 2016).

In terms of religion, Estonia is one of the least religious countries in the world, with 29% of people claiming a religious affiliation of some form (Statistics Estonia 2011). Most people who live in Estonia claim to be Orthodox Christians (16%), with these mainly being drawn from the Russian-speaking population, followed

by Lutherans (10%) who are mainly Estonians. In terms of the celebration of holidays some notable differences have to be mentioned. For Estonians, Christmas, Midsummer's Day, and New Year's Eve are important days for celebration. Russian speakers are, on the other hand, largely influenced by Russian and Orthodox traditions, so that they are more observant of the Russian New Year, Maslenitsa, and Christmas, even when living in Estonia (Seljamaa, 2010). Estonians and Russians celebrate Christmas at different times. Celebrating Midsummer's Day has, though, gained popularity amongst the Russian-speaking community in Estonia (Seljamaa, 2013).

4. METHODOLOGY

4.1 Mobile positioning data

All human activities have spatio-temporal characteristics which are both inseparable and crucial when it comes to reaching any understanding of individual activity spaces (Kwan, 2007). Mobile phone data is a rich element of these components. Mobile phone positioning data has proved its usefulness in various research fields such as transportation, human mobility, activity spaces (Calabrese et al, 2010; Järv et al, 2014; Kamenjuk, Aasa, & Sellin, 2017; Yuan, Raubal, & Liu, 2012), migration (Lai et al., 2019), tourism (Saluveer et al., 2020), and carbon footprint research (Poom, Orru, & Ahas, 2017). This form of data has also been widely applied in studies which focus on ethnic differences in activity spaces (Raanan & Shoval, 2014; Silm & Ahas, 2014a; Xu et al, 2019).

In the current thesis, all four articles utilise passive mobile positioning data (Silm, Järv, & Masso, 2020) which comes from Estonian mobile network operators (MNO, Table 1). Call Detail Records (CDRs), such as phone calls, text messages, and data communications, is one form of passive mobile positioning data. CDRs are composed of the elements of time and the spatial location of call activities, with the accuracy levels reaching down to individual antennae, and randomly-generated anonymous identification codes for each caller which is automatically stored in the log files of the MNOs. CDR data is used in **Articles I**, **II**, **III**, and **IV**. Call-graph data which is composed of linked anonymous identification codes (ID codes) for the caller and calling partners is used in **Article IV**. The market share is approximately one third of each of the MNOs whose data is utilised in this thesis.

In addition to CDR and call-graph data, social characteristics (gender, year of birth, and preferred language of communication for phone user) are available for scientists, with such information being linked via ID to mobile phone data if required. Social characteristics are derived when an individual signs a contract with the MNO, which means that the values for those characteristics are self-chosen. The preferred language of communication is of primary interest in this thesis because language is an important aspect of ethnic and cultural identity in Estonia (Mägi et al., 2020; Vihalemm, 1999), based on which the Estonian-speaking and Russian-speaking population can be distinguished. The Estonian-speaking population (which carries out 4.3 call activities a day) and the Russian-speaking population (which carries out 4.4 call activities a day) have similar calling habits ($p > 0.05$; **Article I**). According to the Eurobarometer study (2014), a total of 94% of Estonian population have access to mobile phones.

MNOs collect various forms of mobile phone data,[1] out of which domestic customer data and outbound roaming service data for Estonian operator's clients when they travel abroad are being used in this thesis. Domestic data has been

[1] Mobile network coverage in Estonia is at 99%, and signal strength is generally very good (Estonian Consumer Protection and Technical Regulatory Authority, 2019).

used in **Articles I, II, III,** and **IV**, and outbound data in **Article III**. The generation of meaningful activity locations from domestic data is a task which is carried out using a similar methodological approach as that described by Ahas and others (2010). With the temporal accuracy of one month, the model applies eight steps in order to detect an individual's residential, workplace, and secondary locations. Pre-processing and the generation of trips from outbound data is described by Saluveer and others (2020). For outbound data, the country of origin is always Estonia, and destination countries are depicted by ISO alpha 2 codes.

Various samples have been constructed in the articles which constitute this thesis. The main principles when it comes to composing samples is, firstly, randomly selecting an equal ratio of members who belong to those groups that are being observed and, secondly, selecting members based on residential distribution in the census. Additional criteria in all four papers included the presence of all social characteristics (some people in the database do not have social characteristics at all or have only few variables). In order to be included in the study people had to have age, gender, and language variables. In all four articles residential place (**Articles I, II, III,** and **IV**) was calculated based on the aforementioned anchor point model (Ahas et al., 2010), while in three articles workplace was used (**Articles I, II,** and **IV**). The presence of these variables in addition to the socio-demographic variables was required in order to be included in the samples. In **Article I** the sample consisted of a randomly-selected group of 12,500 people who were living in Tallinn, of which half were Estonian and half were from the Russian-speaking population. The equal ratio was intentional for comparative reasons. In **Article II** the full sample consisted of 2,500 Tallinn residents whose residential distribution matches up to the 2011 census. Since the primary focus of the study was on ethnic differences across age groups, an equal proportion of 500 people from each age and language group was derived for comparative reasons. In **Article III** all of those people who had made at least one trip abroad during the period 2014–2016, had all of their social characteristics and residential place were included in the sample. This resulted in a sample size of 75,118 people. In **Article IV**, the sample size was 13,021 and, in addition to having all of the social characteristics and calculated residential space of the caller, people also had to have at least some call activities for at least seven months, with 50% of call activities to calling partners having to be made inside one MNO, and with some additional criteria being set out for calling partners. Sample was weighted by using as a basis the distribution of Tallinn residents from the 2011 census.

The period of time which is being studied in the various articles varies from one year (**Articles II** and **IV**) to three (**Article III**), and four (**Article I**). Usually the analytical unit in the articles was an individual and their specific characteristics (Table 1). However, in **Article I** the analytical unit was a day, which means that in addition to a sample which was composed of people, a sample was also constructed which was composed of various public and national holidays in 2007–2010. Estonian public holidays (n=30 days) are non-working days in

Table 1. An overview of data used, and methods and measures used regarding segregation and activity space in **Articles I, II, III**, and **IV**.

	Article I	**Article II**	**Article III**	**Article IV**
Data	domestic CDR	domestic CDR	domestic CDR, outbound CDR	domestic CDR, call-graph
Sample	6,250 EST and 6,250 RUS-speaking Tallinn inhabitants	2,500 EST and RUS-speaking Tallinn inhabitants	75,118 EST and RUS-speaking people with outbound visit(s)	13,021 EST and RUS-speaking Tallinn inhabitants
Period of time	2007–2010	2011	2014–2016	2016
Activity space	▪ Out-of-home non-employment activity places	▪ Full activity space ▪ Residential place ▪ Workplace ▪ Out-of-home non-employment activity locations	▪ Cross-border mobility ▪ Residential place (county)	▪ Full activity space ▪ Residential place ▪ Workplace
Measure of segregation	Dissimilarity index	Dissimilarity index	–	–
Measure of activity space	▪ % of Russian speakers in visited districts	▪ 95% SD ellipse ▪ Entropy ▪ Number of visited districts ▪ % of Russian speakers in visited districts	▪ Number of trips ▪ Average trip duration ▪ Number of days spent abroad	▪ Number of visited districts ▪ % of Russian residents in workplace district ▪ % of Russian residents residential district
Statistical analysis method	▪ Over-dispersed Poisson regression ▪ GLM[2] ▪ Spearman correlation	▪ GLM ▪ Kruskal-Wallis test	▪ Zero-truncated negative binomial regression ▪ Negative binomial regression ▪ Binary logistic regression	▪ Negative binomial regression ▪ GLM ▪ Binary logistic regression ▪ Spearman correlation analysis
Analytical unit	Day	Individual	Individual	Individual
Predictor variables in the models	▪ Holidays ▪ Seasons ▪ Weekdays	▪ Language ▪ Gender ▪ Number of call activities	▪ Language ▪ Gender ▪ Age ▪ Residential area	▪ Language ▪ Gender ▪ Age ▪ % of Russians in residential district ▪ % of Russians in workplace district ▪ Number of call activities ▪ Number of calling partners ▪ Ethno-linguistic composition of social networks

[2] General Linear Model.

Estonia which have been established by legal acts; Russian public holidays (n=35) are non-working days in Russia which have also been established by legal acts; international holidays (n=25) are celebrated both in Estonia and Russia; Estonia's other holidays (n=76) cover Estonian religious, folk, and event days which remain work days; other Russian holidays (n=40) cover Russian folk events and religious days which are also work days.

The collection, storage, and processing of data is in accordance with EU requirements regarding the protection of personal data, as per EU directives on handling personal data and the protection of privacy in the electronic communications sector through the European Union Data Protection Regulations (European Parliament and Council of the European Union 1995, 2002, 2016).

4.2 Measures of activity space

An individual's activity space consists of various meaningful locations, along with the mobility in between these spatial locations (Figure 1). Based on domestic data and the anchor point model which was developed by Ahas and others (Ahas et al., 2010), residential place, workplace, and secondary anchor points can be determined. As mentioned in Chapter 4.1, the presence of some of these locations is used as selection criteria in sampling. However, in addition to this, separate activity places are also subject to empirical analysis in this thesis.

With mobile phone data it is possible to cover the full human activity space and, with the anchor point model (Ahas et al, 2010), it is possible to detect separate activity locations. In **Articles II, III,** and **IV**, residential place was analysed. In **Articles II**, **IV** analysis covered workplace, while in **Articles I, II** it covered out-of-home non-employment activity places. Out-of-home non-employment activity places were used to represent leisure time activities. In addition to separate activity places, the full activity space was also analysed in **Article II**. Temporary cross-border mobility was a subject for the study in **Article III**.

Studies which deal with the human activity space usually consider human activities and mobility inside one country. However, the spatial reach of human activities – especially prior to the arrival of COVID-19 – also extends to nation-state borders (in terms of permanent migration, job-related commuting, visiting friends and family abroad, cross-border shopping trips, etc), all of which calls for an extension of the traditional concept of the activity space. For this purpose, the 'transnational activity space' is proposed in **Article III**, which takes into account permanent and temporary cross-border mobility (Figure 2). The extension is necessary in the view of the author of this thesis as, firstly, it draws attention to the changed spatialities of modern human actions. This shift in focus also introduced the question of data. Traditional cross-border commuting has been captured by tourism statistics. However, the collection of this data is somewhat problematic in the Shengen area, where not all tourists are actually tourists but can instead be work commuters, for example. Mobile phone roaming service data is a very useful source of data when it comes to measuring cross-border mobility

(Raun, 2020). Secondly, in terms of segregation, cross-border mobility affects everyday life and choices. For example, permanent migration is the reason that challenges exist which can be related to the settlement process, while continuing attachment to one's ancestral country can be a source of frequent home country visits, chain migration, or ancestral country media consumption, for example. These activities and related mobilities are important in segregation research because they contribute to everyday life choices, opportunities, identity formation, and even the transfer of (in)equalities, not just between places and generations but also between countries and the preservation of social networks.

The concept of activity space is an individual-based approach. Different measures for activity space segregation describe the extensity, intensity, diversity, exclusivity, and social exposure of an individual's spatial behaviour (Wang & Li, 2016; Wang et al, 2012). The extent and diversity of activity space in this thesis is measured by a 95% standard deviational ellipse in **Article II,** and by the number of visited spatial units in **Articles II** (districts), **III** (countries), and **IV** (districts). Diversity is also characterised by entropy measure (Yuan et al., 2012) in **Article II**, where a higher entropy value denotes an increase of visited districts over many days and '0' denotes a visit to only one district every day. Social exposure reflects the presence of other social groups in one's activity space. This is usually indirectly captured with auxiliary datasets such as censuses (Wang & Li, 2016). In this thesis, census data has been utilised to investigate the ethno-linguistic composition of visited activity locations, which can indicate exposure to members of various ethno-linguistic groups. The percentage of Russian residents in residential place, workplace, and out-of-home non-employment districts has been calculated in **Articles I, II,** and **IV**.

As the focus of **Article III** was on temporary cross-border mobility, the indicators are also somewhat different. Mobility is measured by the number of trips and by different time-based variables (such as average trip duration, and the number of days spent abroad), which describe cross-border mobility intensity. In order to distinguish between various forms of mobility type for visitors to specific destination countries, three variables are used: the frequency of visits to the destination country, the number of days spent in the destination country, and the number of days in one's country of origin (ie. Estonia). Long-term stayers spend most of their time abroad (75% or more time in one destination country). Transnationals are active in many countries at once and move between them: they spend at least 25% of their days in Estonia and between 25–75% of their days in the destination country; they make at least one visit to a country in each of at least six of the twelve months of the year. Commuters travel frequently abroad (making at least two visits to the country in each of at least six out of twelve months of the year), but they mainly reside in their country of origin (at least 25% of their days in Estonia, but less than 25% of their days in the destination country). Tourists visit the destination country irregularly and rarely; these did not fall into any of the aforementioned groups. In order to be able to visualise different activity locations, maps have been composed.

4.3 Measures of segregation

Out of traditional place-based segregation measures, an index of dissimilarity has been calculated in **Article I** and **II**. A dissimilarity index (ID) is probably one of the most widely used traditional (but aspatial) forms of index, one which characterises the dimension of (un)evenness (Massey & Denton, 1988). Evenness denotes the spatial distribution of two ethnic groups out of the total spatial units in a given region. The value of '0' points towards equal distribution and no segregation, while the value '1' indicates very uneven distribution and high segregation. Further index interpretations are provided by Gale (2013) who states that values between 0.00–0.39 can be considered as being low, 0.40–0.49 as moderate, 0.50–0.59 as moderately high, 0.60–0.69 as high, and 0.70–1.00 as very high.

In **Article I**, ID values were calculated for out-of-home non-employment activity locations during holidays and ordinary days. In **Article II**, the values for the ID were calculated separately for residence, work, and out-of-home non-employment activity locations across ethno-linguistic and age groups.

As described in Chapter 4.2, the different person-based measures which describe extensity, diversity, the intensity of one's activity space, and social exposure to other social groups were all calculated. These measures make it possible to compare these indicators across ethno-linguistic groups. The findings point to how a person is using their physical environment, one which may be affected by segregation (such as in terms of various constrains, opportunities, social networks, and preferences). Large differences in these indicators for different groups may point towards large differences in spatial behaviour and life prospects. Such person-based measures help to better explain how the effect of, for instance, living in a segregated neighbourhood affects other life domains, therefore being in accordance with the newest segregation theories (Krysan & Crowder, 2017; van Ham et al., 2018).

4.4 Measures of social networks

Social networks were the focus of **Article IV**. Based on the composition of caller networks, co-ethnic and inter-ethnic social networks were constructed. Co-ethnic networks represent those networks in which all calling partners have the same language of communication as the person making the call. Inter-ethnic networks represent networks in which at least one calling partner has a preferred language of communication that is different from the one being used by the person concerned.

The following ego-centric measures were calculated in order to characterise the size and geographical extent of social networks, and exposure to ethno-linguistic groups: the number of calling partners, the number of residential districts for calling partners, and the average percentage of Russian residents (according to the 2011 census) in the residential districts of calling partners.

4.5 Statistical data analysis

Various sets of statistical analysis methods and modelling techniques were used in the current thesis. The analytical unit in **Article I** was a day, while in **Articles II**, **III**, and **IV** it was an individual. The Spearman ρ correlation analysis was used in **Articles I** and **IV**. In **Article I** this measure was calculated for Russian speakers alone, between the number of Russian-speaking people and the number of Russian residents in the visited districts according to the 2000 census. In **Article IV** the measure was calculated between the proportion of people with inter-ethnic networks and Russian residents in a residential district according to the 2011 census. This was carried out separately for the Estonian and Russian-speaking populations.

GLM was employed in **Articles I, II,** and **IV.** In **Article I** this was used to assess how the values from Spearman ρ are influenced by holidays in general and by holiday types specifically. In **Article II** GLM was used to assess the relationship between different activity space characteristics and socio-demographic variables. Separate models were constructed for each age group. GLM was employed in **Article IV** to discover the relationship between the percentage of Russian residents in visited districts and different independent variables, namely the preferred language of communication, the ethno-linguistic composition of social networks, and the ethno-linguistic composition of residence and workplace. Separate models were constructed for all of the people in the sample, and separately for Estonian and Russian speakers.

Binary logistic regression was applied in **Articles III** and **IV**. In the former publication this was used to assess the odds of belonging to different outbound visitor groups across socio-demographic variables. In the latter publications it was used to assess the odds of having an inter-ethnic network across socio-demographic variables, along with the ethno-linguistic composition of residence and workplace.

As some dependent variables in **Articles I**, **III,** and **IV** were essentially in the form of count data, Poisson-family regression analysis methods were used as suggested in the available literature (Coxe, West, & Aiken, 2009; Huang & Cornell, 2012). As overdispersion ($\mu \neq \sigma^2$) was an issue in all three of those publications, this was tackled by employing different Poisson family regression models: overdispersed Poisson regression in **Article I** (regarding the number of Estonian speakers and the number of Russian speakers), negative binomial regression in **Article III** (covering trip duration and the number of days) and also in **Article IV** (covering the number of visited unique districts), and zero-truncated negative binomial regression was used for **Article III** (covering the number of trips and the number of countries visited).

5. RESULTS

5.1 Activity space segregation in Estonia and abroad

Spatial segregation when measured with an index of dissimilarity between Estonian and Russian speakers living in Tallinn is at its highest in the residential place (ID=0.39) and workplace (ID=0.34), resulting in moderate levels of spatial separation (**Article II).** The segregation level is rather small and at its lowest in out-of-home non-employment activity districts, in which the values for the dissimilarity index reach 0.19 in **Article II** and 0.21 in **Article I**.

When considering the whole activity space in Estonia, ethnic differences become evident (Figure 6). Russian speakers have in general smaller and less diverse activity spaces (covering the number of districts, the area of ellipse in terms of km,^{2} and entropy) than do Estonian speakers, and these differences are statistically significant ($p < 0.01$, Figure 6) (**Articles II** and **IV**). The Russian-speaking population visits fewer districts than do Estonian speakers (**Articles II** and **IV**), namely when the effect is accounted for in terms of other independent variables (such as gender and age, etc), Russian speakers visit 8% fewer districts ($p < 0.01$. **Article IV** Model 4).

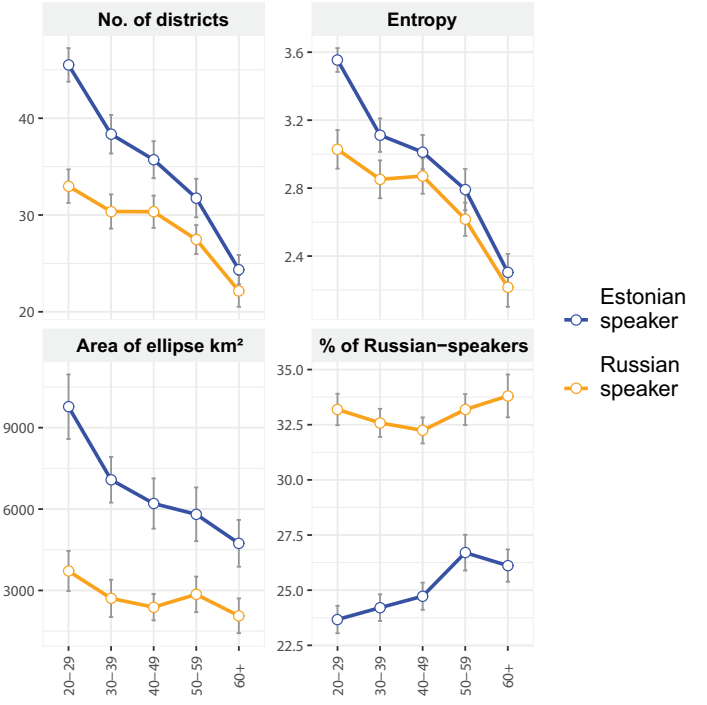

Figure 6. Average values for activity space measures (including the number of districts, entropy, the area of ellipse km^2, and the share of Russian speakers) across age and ethnic groups. Age groups are calculated on the basis of people's age in 2011. Source: **Article II** Figure 4 (modified).

Nowadays, when many people pursue their activities in many countries, an approach which tackles the cross-border extension of activity space is necessary when it comes to understanding the functioning of ethnic communities. This was the study subject in **Article III**, and a new conceptual term of 'transnational activity space' is proposed, which takes into account cross-border mobility. While the Russian-speaking minority has smaller activity spaces in Estonia, the results showed that it has a higher travel intensity in terms of going abroad than does the Estonian-speaking majority population. In fact, during the study period in 2014–2016, Russian speakers made 10% more trips abroad than Estonian speakers. Their average trip length was 14% longer in terms of days spent there, and they spent an overall figure of 17% more days abroad ($p < 0.001$, see **Article III**, Table 3, Models 1–4), when other variables are included in the regression models. Russian speakers also had higher odds of being commuters and tourists (**Article III**, Table 3, Models 5 and 6) when compared with the Estonian-speaking population.

5.2 The persistence of segregation over generations

Segregation is a process which incorporates both spatial and temporal dimensions. With regard to temporal dimension, researchers and policymakers are interested in how the process evolves over time and across generations. Since mobile phone data is available for people who were born during the Soviet period or in newly re-independent Estonia of the early 1990s, it is possible to look at segregation levels across different age groups (**Article II**). It is noteworthy that ages are calculated on the basis of people's age in 2011.

The results of **Article II** show that segregation levels are higher in younger age groups than in older age groups, indicating that young Russian and Estonian speakers are more unevenly distributed than older co-ethnics. This is especially evident in places of residence and out-of-home non-employment activity places (Figure 7). Residential and workplace segregation was at its highest in the 30–39 age group (residence ID=0.45, workplace ID=0.48), and at its highest for leisure time segregation in the 20–29 age group (ID=0.23).

With regard to the whole activity space (**Article II**), similar tendencies occur for Estonian and Russian speakers across age groups: the number of visited districts and the extent of the activity space decreases linearly with age (Figure 6). Estonian speakers in all age groups have far more extensive use of space when compared with Russian speakers. This means that they visit more districts and their spatial behaviour is more extensive. However, the range of activity space characteristics across age groups is higher for Estonian speakers than for Russian speakers. For example, 20–29 year-old Estonian speakers visit an average of 21.1 districts more than their aged 60+ co-ethnics, while for Russian speakers the figure is 10.8 districts.

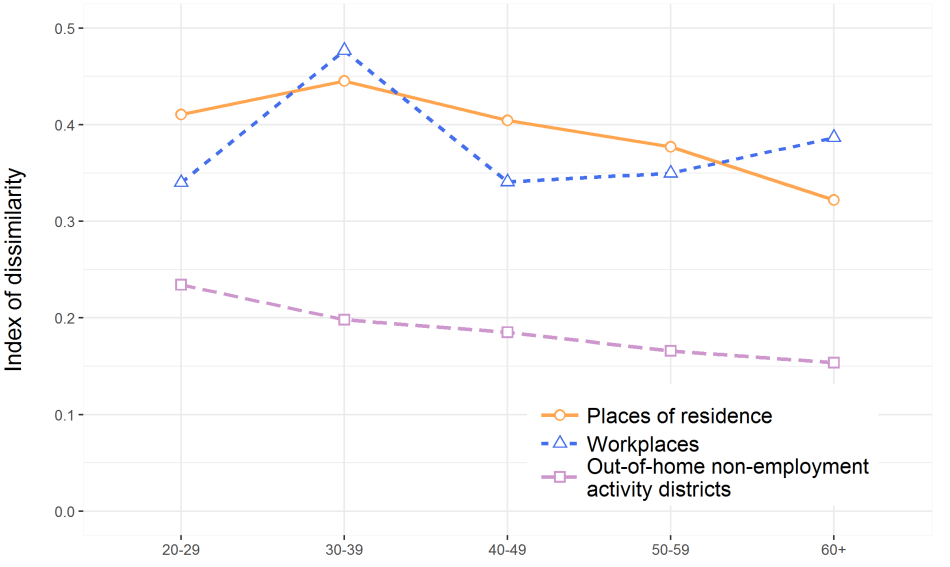

Figure 7. Values for the dissimilarity index by age groups and activity locations. Source: **Article II** Figure 1 (modified).

An indicator which can be attributed to social networks and preferences is that of the percentage of the Russian-speaking population in visited districts (**Article II**). Russian speakers clearly visit districts which have a higher shares of their co-ethnics across all age groups than do Estonian speakers (Figure 6). The difference in the ethno-linguistic composition of visited districts between two ethno-linguistic groups is at its highest in the youngest age group of 20–29 (at 9.2 percentage points), and smallest in the 50–59 age group (at 6.7 percent points). This implies a higher segregation in the second generation, with younger Estonian speakers tending to go into areas in which more Estonians reside when compared to their older co-ethnics ($p < 0.01$). Interestingly, there is no statistically significant relationship ($p > 0.1$) between the percentage of the Russian-speaking population in visited districts and age groups for Russian speakers. This means that age does not influence the ethno-linguistic composition of visited districts for the ethno-linguistic minority population.

A continued attachment to the country of ancestry (Russia) for the younger Russian-speaking population age groups was observed in **Article III**. The top three visited countries for Russian speakers are Russia (visited by 65% of the research population), Latvia (49%), and Finland (37%). While the proportions vary, the sequence remains the same across age groups. This indicates that younger age groups which are more prone to mobility tend to keep close connections to Russia. The situation for Estonians is somewhat different; older Estonian speakers predominantly visit Latvia, while younger Estonian speakers visit Finland.

5.3 Temporal variations in segregation: the case of holidays

Spatial segregation is a complex process, one which evolves over a long period of time. It is relatively persistent over generations, as is discussed in Chapter 5.2. It is a process that has been traditionally measured using census data, which makes it possible to view the process over decades. However, with the emergence of new and temporally-precise data, it is now possible to measure the fluctuation of segregation over shorter period of times.

Holiday time is typically attributed to leisure time activities. During a holiday, especially when such a holiday is accompanied by days that are free of any responsibility, people conduct activities that can be seen as being different from those of their normal days, which is evident in their spatial behaviour. Within the context of segregation, however, holidays may serve different meanings, traditions, and actions for various ethno-linguistic groups. This can be seen in their out-of-home non-employment activity locations (**Article I**). During a holiday period in general terms, people leave the capital city of Tallinn, with the result that the number of Estonian and Russian speakers who are outside their home and work locations decreases in Tallinn and increases across the rest of Estonia. Segregation levels which are measured using an index of dissimilarity tend to increase slightly in Tallinn and in the rest of Estonia (Table 2).

Estonian public holidays are the most influential holiday type due to their associated free days. The number of Estonian speakers who leave their home city is greater than it is for Russian speakers, and the statistically significant difference becomes evident, especially in Estonia outside of Tallinn: when holding other variables to be constant, the number of Estonian speakers increases to 77% and the number of Russian speakers increases to 33% when compared to normal workdays ($p < 0.01$) (**Article I**). The spatial distribution of Estonian and Russian speakers is at its most uneven during Estonian public holidays, both in Tallinn and outside the capital. In Tallinn the segregation levels outside home and workplaces increase slightly when compared to regular days (a regular day has ID=0.205, while a holiday day has ID=0.227, $p < 0.01$) but still manage to remain low overall. In Estonia segregation levels increase further (a regular day is ID=0.373, while a holiday day is ID=0.475, $p < 0.01$) and tend to be moderate.

International holidays are celebrated both in Estonia and Russia (**Article I**). During these days people also leave their home city. However, changes in the number of people are smaller when compared to figures for Estonian public holidays (Table 2).Changes in spatial distribution follow a similar pattern as they do for Estonian public holidays: segregation levels increase but remain low in Tallinn ($p < 0.01$) and in the rest of Estonia they remain moderate.

Segregation is at its highest in Tallinn during New Year's Eve (ID=0.271), and in the rest of Estonia during Christmas Day (ID=0.526).

Table 2. The average number of Estonian and Russian speakers and the average value for the dissimilarity index during holidays and normal workdays. Source: **Article I** (modified).

	Number of Estonian speakers		Number of Russian speakers		Index of dissimilarity	
	Tallinn	Estonia	Tallinn	Estonia	Tallinn	Estonia
Holiday day vs regular day						
Holiday	2,325	1,079	2,516	720	0.214	0.406
Regular day	2,570	966	2,681	711	0.205	0.373
Types of holidays						
Estonian public	1,647	1,717	2,027	946	0.227	0.475
Russian public	2,515	789	2,642	596	0.213	0.400
International	2,264	1,171	2,557	699	0.224	0.439
Estonian other	2,456	924	2,580	675	0.210	0.374
Russian other	2,475	1,064	2,630	753	0.207	0.392

5.4 Interlinkages between the social networks and activity space of ethno-linguistic groups

Social networks are one of the most important drivers when it comes to the wider areas of discussion in the available segregation literature. However, the impact of social networks on segregation has been relatively hard to measure due to a lack of data and multi-directional causality between the networks and spatial behaviour.[3] All four articles in this thesis have observed the relationship between social networks and spatial behaviour or segregation either directly (**Article IV**) or indirectly (**Articles I, II,** and **III**).

In **Article IV** the relationship was observed between social networks and spatial behaviour. With call-graph data it is possible to distinguish the calling partners network composition for individuals. Based on an individual's and calling partners' preferred language of communication with the MNO, networks were divided into co-ethnic and inter-ethnic. The results showed that inter-ethnic networks (networks which were comprised of Estonian and Russian speakers) are more common amongst Russian speakers: a total of 45% of the Russian-speaking research population had inter-ethnic networks, while for Estonian speakers this figure was only 10%. People with co-ethnic networks form two extremes in terms of the spatial reach of their activities. Estonian speakers with co-ethnic networks

[3] The author of this thesis is fully aware of the mutual causal relationship between social networks and spatial behaviour, and does not therefore confidently state which affects what. Terminology such as 'impact', 'influence', etc, is used to illustrate the relationship between networks and spatial behaviour. They do not imply causality as this was not directly observed in the articles.

have the widest activity spaces (on average covering 37 visited districts), and Russian speakers with co-ethnic networks the narrowest (on average covering 28 visited districts) (see Figure 8). The impact of having inter-ethnic networks has a two-way effect on activity space across ethno-linguistic population groups. Estonian speakers with inter-ethnic networks visit 12% fewer districts than do Estonians with co-ethnic networks ($p < 0.01$, **Article IV** Model 6). On the other hand, Russian speakers with inter-ethnic networks visit 4% more districts than do Russian speakers with co-ethnic networks ($p < 0.01$, **Article IV** Model 7).

There is also a significant relationship between the composition of social networks and visited destinations (districts). People with co-ethnic networks visit destinations in which the share of the opposing ethno-linguistic group is smaller. Having an inter-ethnic network is also reflected in the spatial behaviour of groups, but in the opposite direction. Estonian speakers with inter-ethnic networks visit districts which have a higher average share of Russian speakers (30%) than co-ethnics (25%, $p < 0.01$, **Article IV** Model 10), and Russian speakers with inter-ethnic networks visit districts which have a lower average share of Russian speakers (32%) than co-ethnics (34%, $p < 0.01$, **Article IV** Model 11).

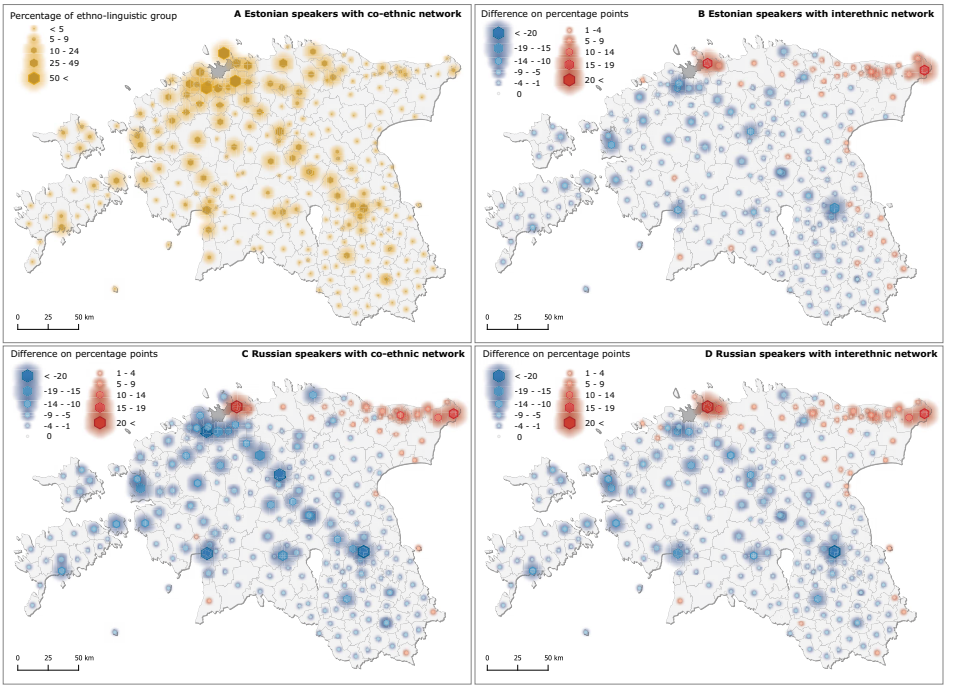

Figure 8. The ethno-linguistic composition of social networks and visited districts. Estonian speakers with co-ethnic networks (A) are taken as a basis from which is mapped the percentage point difference for the number of people in other categories (B, C, D). Source: **Article IV** Figure 3.

The results from **Article II** show that Russian-speaking minority population tends to visit more districts which are dominated by Russian-speaking residents when compared to Estonian speakers, and that this is consistent across all age groups ($p < 0.01$; **Article II** Table 2). With regard to the geography of the areas being visited, the influence of social networks especially occurs in out-of-home non-employment activity locations that are outside Tallinn during regular days (**Article II** Figure 3), and also during holiday periods (**Article I** Table 3). Visits by the Russian-speaking population dominate in the north-eastern districts and around Lake Peipus, where lives a high share of Russian residents. During holiday periods in Tallinn there are slightly less Russian-speaking people in the Russian-dominated districts than during normal times (holiday: Spearman $\rho=0.67$, normal period: Spearman $\rho=0.68$, $p < 0.01$, **Article I**). Interestingly, this relationship occurs only during Russian public holidays (Spearman $\rho=0.66$), when places in which meetings and celebrations may occur could be located nearer the city centre where less Russian speakers normally reside. In Estonia, outside of Tallinn, the relationship has the opposite direction (holiday periods: Spearman $\rho=0.43$; normal periods: Spearman $\rho=0.40$, $p < 0.01$). This relationship is statistically significant during those holiday periods which are mainly accompanied with free days, ie. Estonian public holidays (Spearman $\rho=0.50$, $p < 0.01$) and international holidays (Spearman $\rho=0.45$, $p < 0.01$), such as Midsummer's Day and Christmas (**Article I** Figure 2). During this time the Russian-speaking population visits districts which have a higher shares of Russian residents than they do during regular days.

Interlinkages between social networks and cross-border mobility can also indirectly be detected in **Article III**. The number one destination country for the Russian-speaking minority is Russia. Clear preferences for a destination country tend to emerge when visitor groups are considered which can be attributed mainly to leisure time or short-term working activities (commuters and tourists). For Russian-speaking commuters and tourists, the main destination country is Russia, visited by 40% and 65% of the research population respectively (Figure 9b, Figure 9d). For Estonian-speaking commuters it is Finland (44%, Figure 9a), and for Estonian-speaking tourists it is Latvia (61%, Figure 9c).

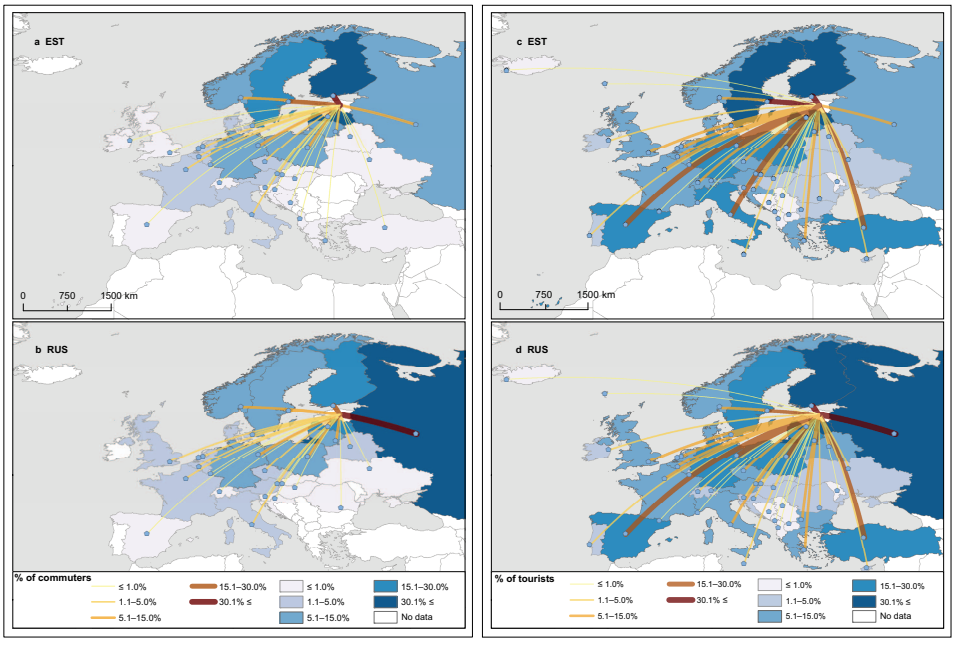

Figure 9. Visits to destination countries by proportions of Estonian-speaking and Russian-speaking commuters (a, b) and tourists (c, d). Source: **Article III** Figure 4.

5.5 Residential and workplace effects on activity space, and the ethno-linguistic composition of social networks

The latest segregation theories stress the transmission of segregation from one domain to other, justifying the activity space approach in which the full range of activities and their locations are brought under observation. The results of this thesis indicate the effect of residential place (**Articles IV** and **III**) and workplace (**Article IV**) on the characteristics of activity space and on social networks. It is noteworthy that even though significant relationships were observed, this does not imply causality.

People who live in areas of Tallinn which are dominated by a minority population visit fewer districts in Estonia (**Article IV**, Table 3, Models 4–7), and those destination districts have higher shares of Russian-speaking residents (**Article IV**, Table 3, Models 8–11) when compared to people who live in mixed areas in terms of the ethno-linguistic composition of the residents of those areas. People who are living in north-eastern Estonia, in a region in which the Russian-speaking minority forms a regional majority, have lower cross-border mobility intensity when compared to other regions in Estonia (**Article III**).

Residential space also affects the ethno-linguistic composition of social networks (Figure 10, Article IV**).** The proportion of Estonian-speaking people with inter-ethnic networks is higher in districts with higher shares of Russian speakers

(Spearman ρ=0.66, p < 0.05). For Russian speakers this correlation is negative and non-significant: the proportion of Russian-speaking people with inter-ethnic networks is higher in those districts in which the share of Russian speakers is smaller (Spearman ρ= –0.32, p > 0.05).

In terms of workplace, people who work in areas in which Estonians make up the majority of the residential population visit a higher number of districts. This applies both to Estonian and Russian-speaking populations (**Article IV,** Table 3, Models 4–7). If a person works in a majority-dominated district, the share of Russian residents in visited districts is smaller (p < 0.01, see **Article IV,** Table 3, Models 8–9).

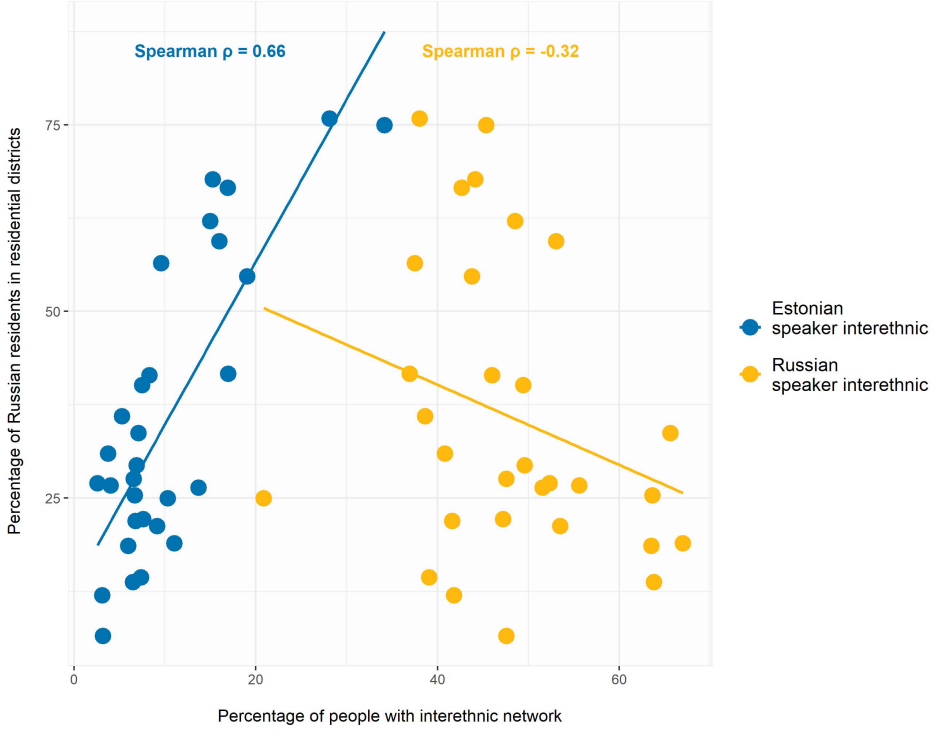

Figure 10. The relationship between the ethno-linguistic composition of residential space and social networks. Source: **Article IV** Figure 2.

6. DISCUSSION

Segregation is a process that is relatively persistent across time. In policy discourses it is often seen in a negative light (Bolt et al., 2010). The traditional viewpoint of segregation revolves mainly around residential space, and the implications of this can also be seen in integration policy measures: the regulated spatial allocation of residential units for minorities typically aims towards creating a spatial mix of different ethno-linguistic groups. Despite various political efforts, the levels of segregation in various European cities seem rather to be increasing than decreasing (Musterd et al, 2017), which is why segregation theories have been calling out for an upgrade in order to better explain the occurrence and persistence of segregation. The approach of activity space segregation makes it possible to shift the focus away from residential places to other spatial settings and timeframes which cover human activities. This in turn helps in better understanding the everyday life experiences of individuals, and also their access to opportunities (Jones & Pebley, 2014; Schnell & Yoav, 2001; Wong & Shaw, 2011). This thesis can be tied in with the activity space segregation framework because it places individuals at the centre of the analysis (**Articles II, III,** and **IV**), while also observing ethnic differences in a whole and various parts of the activity space in particular (**Articles I, II, III,** and **IV**), and incorporates the temporal dimension into the analysis (**Articles I** and **III**).

By employing mobile positioning data, this thesis serves to contribute towards the existing collection of segregation literature in multiple ways, while also uncovering new aspects. Firstly, the transnational concept regarding the activity space was proposed in **Article III**, serving to draw attention to the need to observe the entire activity space, including cross-border mobility and activity places abroad. According to the knowledge of the author of this thesis, temporary cross-border mobility has now been included in segregation research for the first time. Secondly, the differences in activity space segregation levels across age groups were observed in **Article II**, which combines together traditional integration literature with activity space segregation literature. Thirdly, segregation during an irregular timeframe such as public and national holidays were observed in **Article I**. This is the first time that such specific, culturally and emotionally-laden time periods have been included in segregation analysis. Fourthly, a direct link was observed for the first time in **Article IV**, between the ethno-linguistic composition of social networks and activity space. As social networks depict an important causal mechanism for the persistence of segregation, the exact composition of social networks also plays an important role.

This thesis confirmed the existence of segregation between the Estonian and Russian-speaking population in residential place, workplace, and leisure time settings. It also observed differences across the whole activity space (**Articles II** and **I**). Residential segregation levels are higher when compared to workplace and leisure activity locations. The Russian-speaking population in general has less extensive activity spaces, which is something that was measured by the area

of standard deviational ellipses (**Article II**), and the number of visited spatial districts (**Articles II** and **IV**) when compared with the Estonian-speaking population. These results are similar to those of earlier studies which have been conducted within the Estonian context, and which have revealed the existence of segregation in various activity places or across the entire activity space (Kukk et al., 2019; Toomet et al., 2015), along with the persistence of residential segregation (Mägi et al., 2016), and a smaller spatial reach of activities for Russian speakers (Järv et al., 2015).

How activity space segregation varies by age group was the main focus of **Article II**. The results indicate that ethnic segregation and differences in spatial behaviour are more clearly highlighted in younger age groups than in older age groups. This points to the persistence of segregation over generations on the one hand, while on the other hand it highlights non-compliance with the traditional straight-line assimilation model (Alba & Nee, 2003; Gordon, 1964; Massey, 1985). The reasons behind the level of residential segregation for the Estonian and Russian-speaking population have become more pronounced in younger age groups, which can lie partially in the Soviet housing allocation system. During the Soviet period more or less equal opportunities in terms of being able to access all societal segments were provided by centrally-allocating housing units, due to which the segregation levels at the time were lower than they are now (Kährik & Tammaru, 2010). Following the collapse of the Soviet Union, Estonia entered the free market economy, which enhanced socio-spatial stratification based on income, nationality, preferences, and other factors. It can be discussed that the older generation has remained where it was, in its original neighbourhoods, while the younger generation has moved into areas according to the choices of individuals and thanks to opportunities. Mägi and others (2016) have shown that Russian speakers tend to move into areas which have a high proportions of members of their own ethnolinguistic group. Leisure time activities and leisure time places are largely affected by social networks and preferences (Kukk et al., 2019), which form throughout the course of one's life, starting from pre-school and ordinary schooling, and finishing with universities and workplaces. Estonia's two-language school and kindergarten system, however, prohibits the formation of bridging social ties between Russian and Estonian-speaking communities on the one hand, and affects language skills on the other, which can feed into several activity places and life domains (van Ham & Tammaru, 2016; van Ham et al., 2018). However, as some general characteristics which describe Russian and Estonian speakers in various age groups were derived, it is important to note that these groups are not homogenous (see for example Leppik, 2020), and amongst their number are well-integrated and less well-integrated second generation members.

This thesis also took a look at the temporal dynamics of segregation. In **Article I** it was found that there are short-term fluctuations in segregation levels due to national and public holidays. Any changes in segregation levels in Estonia were higher outside Tallinn than they were inside Tallinn. Even though public holidays are often excluded from travel behaviour studies, a few still exist, which show that people undertake longer trips and irregular activities during their holidays

(Cools et al., 2007). Within the context of segregation, this timeframe is important due to several reasons. Firstly, the smaller spatial reach of activities for Russian speakers during any holidays can be the result of socio-economic differences and social networks. Secondly, the undertaken activities and the places in which these occur can very likely be the result of preference: as the available literature claims, some holidays and special celebrations are not simply free time but are inter-twined with cultural meanings and certain functions (Fox, 2006; Scully, 2012; Zhu, 2012). For example, during Russian public holidays in Tallinn, the Russian-speaking population visits out-of-home non-employment activity places which have fewer Russian-speaking inhabitants (**Article I**). This indicates that these activity places are likely connected with traditions and rituals and are situated in the city centre. Thirdly, certain special timeframes (such as public holidays) can be part of the 'materials' from which ethnicity is (re)created and asserted (Floyd, 1998). The relationship between preferences which stem from ethnic background and leisure time is usually investigated in a way which means that leisure time is a dependent variable and ethnic background is an independent variable. In reality a two-way effect can exist here: celebrating public holidays and spending one's free time can help to preserve and express cultural identity (Gans, 1994), and allow individuals to contrast themselves against the majority (Fox, 2006). Therefore leisure time activities can affect the ethno-cultural identity of the person in question.

Integration is highly bound with building inter-ethnic social ties, because having more open and diverse networks is important for success in society (Eagle, Macy, & Claxton, 2010; Verdier & Zenou, 2017). The results from **Article IV** showed that inter-ethnic networks are more common for the Russian-speaking minority than they are for Estonian speakers. This can be partially explained by the fact that Estonian speakers have more potential partners around which co-ethnic social ties can be formed, and can be further amplified thanks to a linguistically-separated school system which prohibits inter-ethnic ties (Masso & Soll, 2014). Other activity places, such as residential and workplace, also affect the chances of forming inter-ethnic ties. The results (**Article IV**) showed that living in a mixed neighbourhood leads to more inter-ethnic networks, both for Estonian and Russian speakers as anticipated based on the available literature (Eisnecker, 2019). Social networks are also highly bound with spatial mobility (Carrasco & Miller, 2009; Puura, Silm, & Ahas, 2018), and the effect of social networks becomes especially evident on public holidays. During holidays, the Russian-speaking minority undertakes visits outside of Tallinn and into districts with a higher share of Russian speakers when compared with more ordinary times of the year (**Article I**). What is more, the available literature has shown that the composition of networks is just as important when it comes to integration: the co-existence of natives and co-ethnics in one's social network is something that is associated with a higher level of integration (Vacca et al., 2018). **Article IV** showed that the ethno-linguistic composition of social networks is related to activity space. Russian speakers with co-ethnic networks have the smallest activity spaces and Estonian speakers with co-ethnic networks have the largest. The social isolation

of the minority in terms of having closed networks is also reflected in its spatial behaviour. However, this does not necessarily imply causality. Having inter-ethnic networks, on the other hand, is associated with visiting districts in which there are more people from the other ethno-linguistic group. With this study (**Article IV**), it was not possible to determine whether inter-ethnic social networks lead to visits to mixed neighbourhoods or *vice versa*: whether visits to mixed neighbourhoods affect the formation of inter-ethnic social networks. This complex relationship between activity spaces and networks has previously been discussed (Carrasco & Miller, 2009; Puura, Silm, & Ahas, 2018), but as mobility and social networks are two important mechanisms through which vicious circles of segregation are (re)produced, further research is necessary in order to investigate the causality and overlapping of these causes.

While the activity spaces of the Russian-speaking population are smaller than those of Estonian speakers in Estonia, their cross-border mobility is more frequent and intense when compared with the mobility levels of the majority population (**Article III**). This result is similar to those from the study which was conducted by Feng and Page (2000) in New Zealand, who found that the Chinese minority there has a higher propensity to travel than does the majority population. This result indicates that the inclusion of cross-border activities is necessary in terms of fully being able to understand the functioning of ethnic communities. When higher incomes are generally associated with higher spatial mobility (Delhey et al., 2015), the results of this thesis indicate that it may not necessarily be the case, since the Russian-speaking population in general has a lower average income when compared to that of the Estonian-speaking population (Statistics Estonia 2020). Cross-border mobility can instead be a means to be able to exit a marginal position in society. The results of **Article III** show that the Russian-speaking minority population has higher odds of belonging to a commuter group than does the Estonian-speaking population (**Article III**). Finding a job in a higher-income country can help to raise one's quality of life and increase access to opportunities in one's country of origin which can in turn result in frequent cross-border commuting (Telve, 2016). Secondly, price differences in terms of goods and services serves to enhance cross-border shopping and is an incentive for irregular and short-term travel abroad. The results revealed that the Russian-speaking population also has a higher propensity to belong to 'tourist' visitor groups, which is something that can be characterised by irregular and short-term travel patterns. Although it is commonly assumed to be the case, income alone may not be the most important predictor in terms of cross-border mobility. Other factors such as social networks and preference very likely also serve to have an effect on choices regarding where to travel (Hughes & Allen, 2010; Williams & Chacko, 2008). The results of **Article III** indicate that the Russian-speaking minority has a strong connection with its ancestral country. The top destination country for different age groups was Russia, which partially indicates the strength of transnational ties over generations, something that was also outlined by Verdery and others (2018). The pull-effect of one's ancestral country is related to preference and a mixed set of reasons, such as discovering one's roots (Hughes & Allen, 2010), or visiting

members of one's social networks (Griffin, 2017), or doing business or taking a holiday (Dwyer et al., 2014), and going to one's ancestral country also allows for low-budget travel (Larsen et al, 2006). Therefore it can be seen that different causal factors very likely overlap. Efforts to understand how and when different factors come into play are necessary in gaining a better understanding of the segregation process (Krysan & Crowder, 2017), but this requires a multi-method research strategy.

Studying (transnational) activity spaces can reveal new aspects and raise new questions that are related to the segregation process. In addition to acknowledging the fact that a person can experience segregation in different activity sites, the way in which segregation is being transmitted from one life domain or part of the activity space to another (Krysan & Crowder, 2017; van Ham et al., 2018) is gaining increasing levels of attention from segregation scholars. Mobility, together with social networks, can be seen as two of the most important mechanisms through which social disparities deepen, are created, or are resolved. In a similar vein, it can and should be asked how and whether cross-border mobility affects the transmission of inequalities from one country to another as has been anticipated within the mobility justice framework (Cass & Manderscheid, 2019; Sheller, 2019). Does the exit from a marginal position through the means of temporary cross-border mobility create new segregated communities in receiving countries? What happens to those with small spatial mobility or who are immobile? The author of this thesis argues that the act of including transnational activities is not merely a matter of conducting the analysis in a new spatial unit, but is more about understanding how individuals seek out ways of exiting a marginal position in society, of how transnational ties help one to be engaged with many countries at once, of how it may affect segregation, and about which new social disparities can emerge due to extensive cross-border mobilities both in receiving and sending countries. Mobility justice framework points to another interesting controversy between traditional place-based segregation theories and new individual-based ones. From the individual's point of view, higher spatial mobility and greater accessibility to opportunities is believed to be desirable, and a form of salvation when it comes to those who are being marginalised. However, where the bigger picture is concerned, this may not be the case. When global mobility volumes, both permanent and short-term, are growing, this tends to create more pressure on vulnerable groups in various geographical regions due to the environmental impact and resulting socio-economic difficulties. Therefore, in order to prevent a shift of inequalities from one region to another, those issues which are related to inequality and segregation must be tackled by using places as a basis, ie. first and foremost in the country in which the problem exists, and as locally as possible.

This leads to the role of data and methods when it comes to measuring segregation. As this thesis mainly employed passive mobile positioning data – thanks to an agreement with mobile network operators – it has several advantages with regard to segregation studies. Firstly, it provides the geographical data on people's activity places based on which entire activity spaces can be constructed, and it also makes it possible to apply the concept of activity space segregation. Secondly,

the dataset has good temporal granularity which makes it possible to study the dynamics of segregation. Thirdly, it is possible to acquire datasets which make possible the study of the effect of social networks on segregation. Fourthly, mobile phone data also makes it possible to study cross-border mobility in order to be able to cover transnational activity spaces. Such mobile phone data is also very useful when it comes to observing the transmission of segregation between different activity places. However, since the methods for measuring activity space segregation originate from mobility and transportation studies, more attention should be paid to developing a common methodological framework. Firstly, segregation is geographically defined by basing it on places: it is about the presence or absence of at least two groups in one spatial unit or another. So far, activity space segregation has been measured by statistically comparing the activity space indicators across different social groups. Therefore it is a matter of further discussion on whether the definition of segregation should be altered to bring it more into compliance with the person-based segregation approach or whether the activity space segregation measures should be developed further to better incorporate the principles regarding the co-presence of individuals, time, and locations. Individual segregation indexes which have been developed by Xu and others (2019), and Park and Kwan (2018) seem promising in this regard. There are also some limitations with the mobile phone data being used in this thesis. Due to a lack of socio-economic variables it is impossible to sufficiently explain differences in terms of spatial behaviour between two ethno-linguistic groups, which is what has occurred in this thesis. It is impossible to confidently claim how much of these differences are actually related to socio-economic disadvantages, ethnicity, social networks, lived experiences, or discrimination. For example, as Jones and Pebley (2014) have demonstrated, the size of the activity space really depends upon the local urban context, and therefore in one country smaller spaces could be a reflection of a disadvantaged position, while in another country more extensive spaces can indicate disadvantages. What is more, to be truly able to break down the vicious circles of segregation, it is important to understand the overlapping causal effects of different factors. This, however, needs a multi-method research strategy, one in which quantitative and qualitative methods are combined.

A better understanding of when, why, and how segregation is transmitted helps in terms of being able to update anti-segregation policies, which nowadays have mainly been concentrated on residential space (Bolt et al., 2010). Activity space segregation and segregation circle frameworks improve understanding in terms of segregation in different parts of the activity space being related. Therefore any integration measures should more actively tackle other parts of the human activity space as well. Even though the focus in activity space segregation theories is on the individual, place-based segregation studies are still relevant. The author of this thesis would argue that these two approaches should not be seen as necessarily opposing each other, as individual-based interaction still takes place in certain places and the characteristics of the place are important (Silver, Byrne, & Adler, 2021). This thesis has demonstrated in all four articles that the spatial behaviour of different ethno-linguistic groups is highly related to social networks.

In this view, Estonian policymakers should also see the formation of inter-ethnic ties as a way in which vicious circles can be broken and integration enhanced. Integration is a process which involves both parties (the minority and the majority), and so does the formation of social ties. Various studies have concluded that mutual interest, trust, and understandable communication are necessary for inter-ethnic contact (Grossetti, 2005; Heizmann & Böhnke, 2016). The place (!) for creating the grounds for mutual interest and communications is, for example, in pre-school and school facilities. Growing and learning in an integrated Estonian school system will help to create a better mutual understanding of each other's languages and cultures, and will serve to improve the Estonian national identity. This hopefully will have positive implications in other life domains, and will help to break the vicious circle of segregation.

7. CONCLUSIONS

With segregation and its related consequences being very pressing issues in a good many societies, researchers have started to consider the process more comprehensively, capturing the entire human activity space and placing under sharp focus the transmission of segregation from one life domain to another. This approach benefits from new datasets which have been derived from mobile phones, GPS devices, and social media as these areas make it possible to capture different parts of a person's activity space. By employing passive mobile positioning data, this thesis aimed to better understand activity space segregation and the relationship between a person's ethno-linguistic background, activity space, and social networks. Call Detail Records and call-graph data from the years 2007–2016 covering two of the largest ethno-linguistic groups in Estonia were used to fulfil the stated aim. Different place-based segregation measures and person-based activity space measures were used to describe the levels of segregation and people's activity spaces.

This thesis concludes that the highest segregation levels for the Estonian and Russian-speaking populations exist in terms residential space. Segregation levels are more pronounced in younger age groups, which indicates the persistence and increase of segregation over generations. Estonian speakers generally have larger activity spaces in Estonia when compared with the Russian-speaking population. However, as people nowadays (at least before the advent of COVID-19) cross borders very frequently due to working, shopping, studying, or living abroad, segregation studies should consider the full range of activity locations. An extension of the traditional concept of the activity space was proposed, with transnational activity space taking into account cross-border mobility and activities. By considering short-term cross-border mobility, it was revealed that the spatial mobility of the Russian-speaking population is more intense when compared to that of the Estonian-speaking population. The results also showed that one of the main destination countries for Russian speakers is Russia, which illustrates the continuing attachment of ancestral country. This raises new questions and research topics which are related to segregation: which role is played by spatial mobility in terms of the transmission of inequalities from one region to another, and which role is played in terms of the persistence of segregation.

This thesis has also shed some light on the temporal dynamics of segregation through the example of public and national holidays. The activity space segregation approach stresses the need to incorporate time into segregation research. A specific timeframe – that of national and public holidays – was observed within this thesis. The results indicated that, during public holidays which are often related to social ties and cultural traditions and activities, segregation levels generally increase. This was especially evident during those days which were accompanied by free days, such as Estonian public holidays and some international holidays.

The effect of social networks on people's spatial behaviour became evident in all four of the studies which are included in this thesis. Generally, the Russian-

speaking population tends to visit more districts that are dominated by Russian-speaking residents, especially in areas outside of Tallinn. Visits largely occur in north-eastern Estonia and near Lake Peipus where resides a high share of Russians. The effect of social networks also became evident during public holidays: more people visited areas with a higher share of Russian residents. However, when the real ethno-linguistic composition of social networks is observed, inter-ethnic networks are more common amongst the Russian-speaking population. Interestingly, the ethno-linguistic composition of social networks is also somewhat evident in spatial mobility. Russian speakers with co-ethnic networks have a smaller spatial reach in terms of their activities when compared to Estonian speakers who have co-ethnic networks, while the possession of inter-ethnic networks leads to visits to areas in which the other ethno-linguistic group is also present. The ethno-linguistic composition of residence and workplace also plays a role in shaping social networks. There are more Estonian speakers with inter-ethnic networks in those districts in which the share of Russians is high. Similarly, if a person works in an Estonian-dominated district, the share of Russian residents in the visited districts is smaller. Unfortunately, with the data at hand, it was not possible to determine causality, with the outcome that the direction of causality between the composition of social networks and mobility remains uncovered.

The results of this thesis serve to draw attention towards the necessity of considering integration in relation to the activity space framework. This means that while a social mix is achieved in many countries through residential unit allocation policies, other activity sites such as school, workplace, and leisure space should also be considered as potential venues for inter-ethnic contact. Social networks definitely play a role in the integration process, and social bonding ultimately reflects on a micro scale the two-way process that is also evident in integration. It takes two people to form a social tie, and likewise two social groups (the majority and the minority) to achieve successful integration. Within the Estonian context, a linguistically-separated school system reproduces segregated social networks and activities. The act of bringing together children as early as in kindergarten and school may serve to enhance mutual trust and understanding between different cultures and languages and, thereby, help to break the vicious circle of segregation.

ACKNOWLEDGEMENTS

I am delighted that, finally, it is time to think back along this journey which has brought me to this point. I owe my greatest thanks to my dear supervisors, Siiri Silm and Rein Ahas. I greatly appreciate Siiri's support, time, and dedication when it came to listening to me and discussing subjects with me, be it either in the office on Vanemuise Street, via Skype or on the telephone, or on the skating and skiing tracks in Tähtvere. Rein introduced me to fascinating research topics and welcomed me to MobilityLab. His enthusiasm and broad thinking has been an inspiration to me even though he is no longer physically present with us. I would also like to thank Tiit, whose presentations on the topic of segregation have been inspiring, and whose comments on my work have helped me to improve it.

Big thanks also go to other colleagues in MobilityLab: Age, Janika, Anniki, Kristi, Anto, Mirjam, Ago, Daiga, Kristiina, Pilleriine, Laura, Arvi, Erki, Margus and Frank. Your competence, enthusiasm, and knowledge has been highly inspiring.

My gratitude also goes to other colleagues from CMUS and the geography department. We have fantastic people in the department, with whom it has been very interesting to collaborate during the courses, project proposals, the implementation of the projects, and the co-authoring of articles, or just when enjoying some very interesting discussions. Thank you, Kadi, Johanna, Ingmar, Kadri, David, Karin, Evelyn, Alex, Taavi, Margit, Ain, Kiira, Pille, Szymon, Iuliia and Madli-Johanna.

I have had the luck of being included and actively participating in various projects during my PhD studies. First is the SmartEnCity project, which has turned Tartu into a more liveable city over the last five years, and which has also resulted in a great and enjoyable partnership between some great people from IBS, the Tartu City Government, TREA, and others. Thank you SmartEnCity team! Andra, your English advice has been invaluable! Secondly, I am very glad to have been included in the CCAMEU project. Its wonderful and brilliant researchers have inspired and challenged my thinking a great deal, and have provided food for thought. In addition, collaboration with a number of researchers around the world in various project proposals and conferences has greatly enriched my knowledge and networks.

Last but not least is my dear family which has given me so much invaluable moral support. My deepest gratitude goes to you! Thanks to my mum, who is a great example of successful integration into Estonian society, and for being the initial source of my interest in this topic from the very earliest high school age. Thanks to my dad, who has taught me persistence and not giving up. Enormous support has been provided by Randy: without you the publication at hand would have not been possible at all! Big thanks goes also to Maryte, Madis, Maria, Leila, Veljo and Arvi. I know that my dear grandfather, who was cheering along my entire PhD journey but who lost his dreadful battle against COVID-19 at the time I was finishing the writing, would have proudly placed this 'book' onto his huge

bookshelf. My dear friends, Liisi, Imbi, Kaisa, Hando, and Imre: thank you very much for listening, asking, and discussing!

My little sunshine, Oskar, now knows what is a PhD thesis. One evening when we were finishing a reading of the book, Naksitrallid, he heard the words ‘PhD thesis’ in the final chapter, and cheerfully said: ‘This is what you do: you also write a PhD thesis as they did in this book’. Now I can gladly answer that, finally, it is finished. I am happy that this thesis has answered many of my questions, but also that it has created many new ones.

This work was supported by the Estonian Research Council under grant number PUT PRG306; the Estonian Science Infrastructure Road Map project, ‘Info-technological Mobility Observatory (IMO)’; the University of Tartu’s ASTRA project, PER ASPERA; the European Union European Regional Development Fund; the European Union’s Horizon 2020 research and innovation programme grant agreement, No 691883 (SmartEnCity – Towards Smart Zero CO2 Cities across Europe). Thanks also go to Mobile Network Operators and Positium LBS for the data.

SUMMARY IN ESTONIAN

Etnilise segregatsiooni terviklikuma mõistmise suunas: tegevusruum ja segregatsiooni nõiaring

Rahvusrühmade ruumiline eraldatus ehk segregatsioon on teema, mis on sotsiaalteadlaste ja geograafide huviorbiidis olnud alates XX sajandi esimesest poolest (van Kempen & Özüekren, 1998). Hoolimata erinevatest meetmetest ja integratsioonipoliitikatest on segregatsioon paljudes Euroopa linnades kahanemise asemel hoopis tõusnud (Musterd et al, 2017), sealhulgas ka Eestis (Mägi et al, 2016). Selleks, et kujundada tõhusamaid integratsioonipoliitikaid, on oluline mõista, kuidas erinevad mehhanismid mõjutavad segregatsiooni püsivust ja süvenemist.

Aja jooksul on segregatsioonikäsitused muutunud. Kui algselt keskenduti erinevate rahvusrühmade elukohtade ruumilisele paiknemisele, siis nüüd pööratakse rohkem tähelepanu indiviidile, tema igapäeva tegevuskohtadele ning elukoha muutustele ajas. Erinevad autorid on välja toonud, et lisaks elukohale võib segregatsiooni kogeda erinevates tegevuskohtades, nagu töökohas, koolis, vaba aja tegevustes ja liikumises (Järv et al, 2015; Silm & Ahas, 2014a; Toomet et al, 2015; van Ham et al, 2018; Wong & Shaw, 2011). Seda nimetatakse tegevusruumipõhiseks segregatsiooniks. Segregatsioon mõjutab väga oluliselt inimeste haridusteed, töökarjääri ja edukust ühiskonnas (Krysan & Crowder, 2017). Kui erinevate rahvusrühmade tegevusruumid on väga erinevad, siis see markeerib väga sügavate struktuursete mehhanismide olemasolu, mistõttu erinevad rahvusrühmad elavad nagu paralleelsetes ühiskondades. Sellisel juhul on ka tõenäosus teisest rahvusest inimestega kohtuda väiksem, tegevusruumide osalisel kattumisel sellise kontakti võimalus aga suureneb (Park et al, 2021). Rahvuste vaheliste kontaktide ja sotsiaalsete sidemete tekkimist peetakse üheks integratsiooni soodustavaks teguriks (Vacca et al, 2018). See viitab aga sellele, et segregatsiooni puhul on lisaks ruumilisele mõõtmele oluline ka ajaline mõõde – eri rahvusest inimeste vaheliste sotsiaalsete sidemete tekkimiseks on lisaks ühisele huvile ja üksteise mõistmisele (Grossetti, 2005; Heizmann & Böhnke, 2016) vaja viibida ka samas kohas samal ajal (Toomet et al, 2015). Ent ruumiline eraldatus ja ebavõrdsus ei teki erinevates tegevusruumi osades iseeneslikult. Esile on kerkinud palju komplekssemad segregatsiooni käsitused nagu segregatsiooni tsükli (Krysan & Crowder, 2017) ja segregatsiooni nõiaringi (van Ham et al., 2018) teooriad, mis püüavad mõista ja uurida neid mehhanisme, mille kaudu segregatsioon ühes tegevuskohas mõjutab ebavõrdsuste siiret teistesse tegevuskohtadesse ja eluvaldkondadesse, ning kuidas erinevad põhjuslikud tegurid mõjutavad segregatsiooni taastootmist.

Segregatsiooni nõiaringi teooria keskne idee on see, et inimese erinevad tegevuskohad ja eluvaldkonnad on omavahel seotud ja segregatsioon kandub keerukate mehhanismide kaudu ühest tegevuskohast ja eluvaldkonnast teise (van Ham et al, 2018). Näiteks kui vene rahvusest laps elab venekeelse elanikkonnaga naabruskonnas ja käib vene õppekeelega koolis, siis see soodustab venekeelsete sõprade

tekkimist, mille mõjud ulatuvad edasi töövaldkonda ja täiskasvanuikka. Uuringud on näidanud, et marginaalne positsioon ühiskonnas madalama sissetuleku või diskrimineerimise tõttu võib vähendada võimalusi töö- ja eluasemeturul (Allen & Turner, 2012), väiksemat sotsiaalset kapitali (Heizmann & Böhnke, 2016) ning kehvemat ligipääsu liikuvusele ja teenustele. Vaesemates naabruskondades elavate inimeste igapäevaelu tegevuskohad asuvad teistes sarnastes naabruskondades (Yip, Forrest & Xian, 2016), mistõttu nad puutuvad kokku sarnase sotsiaal-majandusliku taustaga inimestega (Wang & Li, 2016). Kokkupuude teistes piirkondades elavate inimestega kujundab inimese teadmiste baasi ja kogemusi, mis mõjutab valikut, kus elada, töötada või vaba aega veeta (Krysan & Crowder, 2017; Kukk et al, 2019; van Ham et al, 2018; Yip et al, 2016). Inimene võib sattuda nii-öelda nõiaringi, kus erinevates eluetappides tehtud valikud ja kogemused taastoodavad segregatsiooni teistes eluvaldkondades ja hilisemates eluetappides. Selline segregatsiooni nõiaring ilmneb mitmete kattuvate põhjuslike tegurite tõttu, nagu näiteks ajalugu, poliitika, diskrimineerimine, inimeste eelistused, ressursid, elatud kogemused ja sotsiaalsed võrgustikud (Krysan & Crowder, 2017; van Ham et al, 2018). Suhteliselt vähe on teada, millises etapis ja kuidas need põhjused täpselt protsessi taastootmist mõjutavad.

Segregatsioon on ka Eesti ühiskonnas probleem ja selle tase on viimase 30 aasta jooksul kasvanud (Mägi et al, 2016, 2020). Segregatsiooni juured ulatuvad nõukogude aega ja selleaegsetesse tööturu ja sisserändajate eluasemepoliitikatesse (Kährik & Tammaru, 2010). Eestlaste ja venelaste sotsiaalmajanduslikud positsioonid erinevad märkimisväärselt – eestlased töötavad valdavalt „valgekraede" ametites, samas kui vene keele kõnelejad pigem „sinikraede" ametites (Saar & Helemäe, 2017; Tammaru & Kulu, 2003). Sissetulekute erinevused ulatuvad ka eluasemeturule, mille tulemuseks on kõrgem elukohasegregatsioon võrreldes töökoha segregatsiooniga (Toomet et al, 2015). Enamik vene keele kõnelejatest elab Põhja- ja Ida-Eesti suuremates linnades. Lisaks sotsiaalmajanduslikele erinevustele mängivad segregatsioonis rolli ka eelistused ja sotsiaalsed võrgustikud. Eesti haridussüsteem on endiselt õppekeele mõttes eraldatud (eesti ja vene õppekeelega koolide ja lasteaedade olemasolu) ja see mõjutab ka sotsiaalvõrgustike teket.

Segregatsiooniprotsessi keerukuse mõistmiseks on vaja erinevaid andmekogusid ja uurimismetoodikaid. Ühest küljest sobivad traditsioonilised andmekogud, nagu rahvaloendused, registrid, uuringud ja intervjuud, segregatsioonimustrite pikaajaliste muutuste kirjeldamiseks, erinevate tegevusruumi osade uurimiseks ja põhjuslike mehhanismide avastamiseks. Teisest küljest on nende andmetega väga keeruline katta kogu inimese tegevusruumi ja lühiajalisi muutusi segregatsiooni tasemetes. Uued andmeallikad, näiteks mobiilpositsioneerimine, GPS ja sotsiaalmeedia, pakuvad individuaalandmeid, mis katavad tavaliselt suure osa inimeste tegevusruumist ja on suure ajalis-ruumilise täpsusega. Kindlasti ei peaks traditsioonilisi ja uusi andmeallikaid üksteisele vastandama, vaid leidma võimalusi nende kombineerimiseks. Traditsiooniliselt on segregatsiooni mõõtmiseks kasutatud segregatsiooni indekseid (Massey & Denton, 1988), kuid uute segregatsioonikäsituste valguses on vaja kasutusele võtta uusi meetodeid. Tegevusruumi segregatsiooni mõõtmiseks on välja pakutud analüütiline raamistik, mis

toob esile viis mõõdet – tegevusruumi ulatus, tegevuste sagedus, ruumikasutuse mitmekesisus, tõrjutus ja sotsiaalne eksponeeritus (Wang & Li, 2016; Wang et al, 2012). Tegevusruumi segregatsiooni mõõtmise metoodikaid on mõjutanud tegevusruumi uuringud. Näiteks on tegevusruumi ulatust mõõdetud standardhälbe ellipsitega (Järv et al, 2015), puhvritega (Zhang et al, 2019), minimaalse kumera hulknurgaga (Jones & Pebley, 2014) ja intensiivsust kerneli tihedustega (Wang, Li & Chai, 2012; Tan, Chai & Chen, 2019; Zhang et al, 2019).

Doktoritöö lähtub tegevusruumipõhise segregatsiooni ja segregatsiooni nõiaringi teooriatest. Väitekiri põhineb neljal teadusajakirjades publitseeritud teadusartiklil. Töö eesmärk on paremini mõista tegevusruumipõhist segregatsiooni Eestis, analüüsides suhtluskeele, sotsiaalvõrgustike ja tegevusruumi vahelisi seoseid. Töös kasutatakse passiivseid mobiilpositsioneerimise andmeid eestikeelse enamusrahvuse ja venekeelse vähemusrahvuse vahelise tegevusruumipõhise segregatsiooni uurimiseks aastatel 2007–2016. Eesmärgi saavutamiseks püstitati järgmised uurimisküsimused.

1. Millised erinevused tulevad esile eesti ja vene keele kõnelejate tegevusruumides Eestis ja välismaal?
2. Kuidas tegevusruumipõhine segregatsioon varieerub vanusegruppide ja põlvkondade lõikes?
3. Kuidas etnilise segregatsiooni tase ajas muutub?
4. Missugune on seos eesti ja vene keele kõnelejate tegevusruumi ja sotsiaalvõrgustike vahel?
5. Kuidas elukoht ja töökoht mõjutavad tegevusruumi ja sotsiaalvõrgustike etnilis-lingvistilist koosseisu?

Töös kasutatakse passiivse mobiilpositsioneerimise andmeid (Silm et al, 2020), mis pärinevad Eesti mobiilioperaatoritelt. Väitekirjas on kasutatud kahte tüüpi mobiilpositsioneerimise andmeid – kõnetoimingud ja kõnepartnerite andmestik. Kõnetoimingute andmed salvestuvad mobiilioperaatorite andmebaasi automaatselt ja koosnevad kõnetoimingu tegemise asukohast mobiilimasti täpsusega, kõnetoimingu tegemise ajast ja helistaja anonüümsest koodist. Kõnepartnerite andmestik koosneb helistaja ja kõnepartnerite anonüümsetest koodidest. Lisaks kõnetoimingute ja kõnepartnerite andmestikele on sotsiaalsetest tunnustest teada inimese eelistatud suhtluskeel mobiilioperaatoriga, vanus ja sugu. Eelistatud suhtluskeelt kasutatakse etnilise tausta määramiseks, sest suhtluskeel on Eesti kontekstis oluline tunnus, mis eristab eesti keelt kõnelevat enamusrahvust ja vene keelt kõnelevat vähemusrahvust, ja see on tähtis osa etnilis-kultuurilisest identiteedist (Mägi et al, 2020; Vihalemm, 1999). Töös on kasutatud riigisiseste kõnetoimingute ja välismaa rändlusteenuse kõnetoimingute andmeid. Inimese tegevuskohtade määramiseks (elukoht, töökoht, muud kohad) on kasutatud ankurpunktide mudelit (Ahas et al, 2010) ning välisreiside tuvastamiseks Saluveer jt (2020) artiklis kirjeldatud metoodikat.

Väitekirjas on kasutatud nii traditsioonilisi kohapõhiseid kui ka tegevusruumipõhiseid segregatsiooni mõõtmise meetodeid. Traditsioonilise meetodina on

kasutatud ühtluse indeksit elukoha, töökoha ja vaba aja segregatsiooni hindamiseks ning pühadeaegse segregatsiooni mõõtmiseks. Tegevusruumi ulatust ja mitmekesisust on mõõdetud 95% standardhälbe ellipsiga, külastatud ruumiliste üksuste arvuga ja entroopia indeksiga. Sotsiaalset eksponeeritust on iseloomustatud kaudselt – selleks on kasutatud rahvaloenduse andmeid, et määrata külastatud tegevuskohtade etniline koosseis. Piiriülese liikuvuse puhul on mõõdetud selle intensiivsust. Riikide külastamise sageduse ja välisriigis ning Eestis viibitud päevade arvu alusel on konstrueeritud 4 külastaja tüüpi: pikaajalised viibijad, hargmaised, pendeldajad ja turistid. Sotsiaalvõrgustike koosseis määrati kõnepartnerite suhtluskeele alusel. Kui indiviidi kõnepartnerite seas oli vähemalt üks partner teise suhtluskeelega, siis nimetati suhtlusvõrgustik mitmerahvuseliseks, ja kui kõik kõnepartnerid olid sama suhtluskeelega, siis üherahvuseliseks. Sotsiaalvõrgustike iseloomustamiseks on arvutatud järgmised näitajad: kõnepartnerite arv, kõnepartnerite elukohtade arv, keskmine venelastest elanike osakaal kõnepartnerite elukoha ruumilises üksuses. Andmeanalüüsis on kasutatud erinevaid statistilisi meetodeid nagu Spearmani korrelatsioonanalüüs, GLM, binaarne logistiline regressioonanalüüs, Poissoni perekonna regressioonanalüüsid. Enamikes artiklites oli analüüsitavaks üksuseks indiviid ja tema tunnused. Pühade mõju analüüsivas artiklis oli analüüsiühikuks päev.

Analüüsi tulemused näitasid, et etniline segregatsioon eesti ja vene keele kõnelejate vahel Tallinnas on suurim elukohas (ID=0,39), väiksem töökohas (ID=0,34) ja madalaim nendes tegevuskohtades, mis asuvad väljaspool elu- ja töökohta (ID=0,19; ID=0,21). Kogu tegevusruum on vene keele kõnelejatel väiksem ja vähem mitmekesine kui eesti keele kõnelejatel. Venekeelsed inimesed külastavad vähem erinevaid omavalitsusi kui eestikeelsed inimesed. Ent kui arvestada tegevusruumi hulka ka piiriülene liikuvus, siis vene keele kõnelejad teevad välisriikidesse rohkem reise, nende reisid kestavad kauem ja nad veedavad keskmiselt rohkem päevi välismaal. See tulemus viitab sellele, et oluline on tegevusruumi vaadata võimalikult kompleksena, kaasates ka piiriüleseid tegevuskohti ja liikumisi. Käesolevas väitekirjas pakuti seetõttu välja tegevusruumi mõiste laiendus – rahvusvaheline tegevusruum.

Kui võrrelda tegevusruumi ulatust ja segregatsioonitasemeid vanusegruppide lõikes, siis ilmnes, et noorematel on ootuspäraselt laialdasem ruumikasutus kui vanematel inimestel. Küll aga on segregatsioonitasemed nooremates vanusegruppides suuremad, seda eriti elukohas ja tegevuskohtades väljaspool elu- ja töökohta, võrreldes vanemate vanusegruppidega. See viitab segregatsiooni süvenemisele ja sellele, et integratsiooniprotsess Eestis ei vasta traditsioonilisele lineaarsele assimilatsiooni mudelile (Alba & Nee, 2003; Gordon, 1964; Massey, 1985). Piiriülese liikuvuse puhul ilmnes, et venekeelsete inimeste puhul on kõige olulisem sihtriik Venemaa (65% inimestest oli seda riiki külastanud), järgnesid Läti (49%) ja Soome (37%). Samasugune riikide järjestus ilmnes kõikide vanusegruppide puhul, isegi kõige noorem vanusegrupp hoiab tihedat sidet Venemaaga. Eesti keele kõnelejate puhul on olukord teine, külastatavuse osas on vanemas vanusegrupis esikohal Läti ja noorimas Soome.

Tegevusruumipõhise segregatsiooni käsitus rõhutab ka ajalise dimensiooni olulisust (Silm & Ahas, 2014b). Seda saab mõista mitmeti – pikaajaline vaade näitab, kas ruumiline segregatsioon süveneb või väheneb, ja lühiajaline vaade mismoodi segregatsioonitasemed varieeruvad ja millistel ajahetkedel on rahvusrühmad rohkem eraldunud. Ühe tulemusena ilmnes, et pühade ajal on segregatsioon suurem, seda eriti väljaspool Tallinnat. Eesti riiklikel ja rahvusvahelistel pühadel, millega kaasnevad ka vabad päevad, läheb võrreldes tavapärase ajaga rohkem inimesi pealinnast ära, mistõttu segregatsioon suureneb. Kuivõrd pühade tähistamine on seotud kultuurilise ja etnilise identiteedi säilimisega (Fox, 2006; Scully, 2012; Zhu, 2012), siis liigutakse tõenäoliselt pere, sugulaste või sõprade juurde. Seda kinnitas ka korrelatsioonanalüüs – vene keele kõnelejate arv on tavapärasega võrreldes suurem seal, kus elab rohkem venelasi.

Tendents, et vene keele kõnelejad külastavad kõrgema venelaste arvuga piirkondi, kehtib kõikides vanusegruppides. Suhtlusvõrgustike ja tegevusruumi seost vaadeldi käesolevas doktoritöös ka täpsemalt. Sarnaselt varasematele uuringutele (Eisnecker, 2019) ilmnes, et elamine etniliselt mitmekesise koosseisuga piirkondades viib ka mitmekesisema koosseisuga suhtlusvõrgustikeni. Mitmerahvuselised suhtlusvõrgustikud on rohkem levinud vene keele kõnelejate seas: 45% venekeelsetel inimestel on mitmerahvuselised suhtlusvõrgustikud. Eesti keele kõnelejate seas on see näitaja 10%. Suhtlusvõrgustiku etnilis-lingvistiline koosseis peegeldub ka tegevusruumi ulatuses. Üherahvuselise suhtlusvõrgustikuga eesti keele kõnelejate tegevusruum on kõige ulatuslikum (keskmiselt 37 külastatud piirkonda) ja üherahvuselise vene keele kõnelejate tegevusruum kõige väiksem (keskmiselt 28 külastatud piirkonda). Kui võrrelda keelegruppe siseselt, siis mitmerahvuselise suhtlusvõrgustikuga eesti keele kõnelejatel oli tegevusruum väiksem kui üherahvuselise suhtlusvõrgustikuga eestikeelsetel inimestel. Vene keele kõnelejate puhul oli seos vastupidine: mitmerahvuselise suhtlusvõrgustikuga inimestel oli tegevusruum ulatuslikum kui neil, kellel oli suhtlusvõrgustik homogeensem. Integratsiooni seisukohalt on erinevatest rahvusrühmadest kontaktide olemasolu oluline (Vacca et al, 2018; Marques, 2012; Peters, Finney & Kapadia, 2019). Kahjuks ei olnud selles uuringus võimalik selgitada põhjusliku seose olemasolu ja suunda ruumikasutuse ja sotsiaalvõrgustike koosseisu vahel.

Segregatsiooni nõiaringi (van Ham et al, 2018) ja tsükli (Krysan & Crowder, 2017) teooriad selgitavad, kuidas segregatsioon erinevate tegevuskohtade ja eluvaldkondade vahel on seotud, ja kuidas erinevate mehhanismide koosmõju seda protsessi taastoodab. Käesolevas väitekirjas on vaadeldud elukoha ja töökoha etnilise koosseisu mõju tegevusruumi tunnustele ja sotsiaalvõrgustikele. Tallinna elanike tegevusruum on väiksem neil, kes elavad suure vähemusrahvuse osakaaluga piirkondades, ja nad külastavad rohkem kohti, kus elab rohkem venelasi. Ida-Virumaa elanike piiriülese liikuvuse intensiivsus on madalam, võrreldes teiste regioonidega Eestis. Elukoha ja suhtlusvõrgustike koosseisu vahel on seos – mitmerahvuselise suhtlusvõrgustikuga eesti keele kõnelejate osakaal on suurem nendes piirkondades, kus elab rohkem venekeelseid inimesi. Vene keelt kõnelevate inimeste puhul on seose suund vastupidine, kuid statistiliselt mitteoluline.

Tegevusruum on ulatuslikum inimestel, kes töötavad piirkondades, kus domineerivad eestikeelesed elanikud. See kehtib nii eesti kui ka vene keele kõnelejate puhul.

Käesolev väitekiri on oluline segregatsiooni temaatika arendamisel mitmeti. Esiteks pakuti välja rahvusvahelise tegevusruumi kontseptsioon, mis viitab vajadusele analüüsida kogu tegevusruumi, kaasates ka piiriülest liikuvust ja tegevuskohti välismaal. Töö autori teadmiste kohaselt kaasati lühiajaline piiriülene liikuvus segregatsiooni uuringusse esmakordselt. Teiseks hinnati segregatsiooni erinevates tegevuskohtades vanuserühmade lõikes, mis ühendab tegevusruumipõhise segregatsiooni traditsioonilise integratsiooni lähenemisega. Kolmandaks hinnati segregatsiooni tavapärasest ajast erinevatel ajaperioodidel – riigi- ja rahvuslike pühade ajal. See on esimene kord, kui sellist spetsiifilist, kultuurilise ja emotsionaalse tähtsusega ajaperioodi on segregatsiooni hindamisel kasutatud. Neljandaks hinnati esimest korda seost sotsiaalvõrgustike etnilis-lingvistilise koosseisu ja tegevusruumi vahel. Kuivõrd sotsiaalsed võrgustikud on olulised segregatsiooni taastootvad mehhanismid, on oluline aru saada, milline on seos suhtlusvõrgustike koosseisu ja tegevusruumi vahel.

Parem mõistmine millal, miks ja kuidas segregatsiooni taastoodetakse, aitab kohandada integratsiooni poliitikaid, mis on geograafilisest vaatenurgast lähtudes tänapäeval keskendunud peamiselt elukohtadele (Bolt et al, 2010). Kuivõrd uusimad segregatsiooni käsitused rõhutavad kogu tegevusruumi olulisust segregatsiooni püsimisel, peaksid integratsioonimeetmed aktiivsemalt tegelema ka tegevusruumi teiste osadega. Vastandada ei tohiks traditsioonilisi kohapõhiseid segregatsiooni uuringuid indiviidipõhiste uuringutega, sest inimtegevus leiab aset mingites kohtades, ja seetõttu on koha omadused olulised (Silver et al, 2021). See väitekiri on kõigis neljas artiklis näidanud, et erinevate keelegruppide ruumikasutus on tihedalt seotud sotsiaalsete võrgustikega. Sellest tulenevalt võiks rahvuste või keelegruppide üleste sidemete tekkimist pidada oluliseks hoovaks segregatsiooni nõiaringi katkestamiseks ja integratsiooni edendamiseks. Nii integratsioon kui ka sotsiaalsete sidemete loomine on protsess, mis hõlmab mõlemat osapoolt (rahvusvähemus ja -enamus). Erinevates uuringutes on jõutud järeldusele, et rahvuste üleseks kontaktiks on vajalik vastastikune huvi, usaldus ja ühine suhtluskeel (Grossetti, 2005; Heizmann & Böhnke, 2016). Hea koht sotsiaalsete sidemete tekkeks on näiteks koolieelsed asutused ja koolid. Ühises keeleruumis kasvamine ja õppimine aitab paremini tundma õppida ja mõista üksteise keelt, kultuuri ja seeläbi suurendada eesti rahvuslikku identiteeti. Loodetavasti avaldab see positiivset mõju ka teistele eluvaldkondadele ning segregatsiooni nõiaringi katkemisele.

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Zhu, L. (2012). *National holidays and minority festivals in Canadian nation-building*. PhD thesis. University of Sheffield.

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Silm, S., Mooses, V., Puura, A., Masso, A., Tominga, A., Saluveer, E. (forthcoming). The relationship between ethno-linguistic composition of social networks and activity space: a study using mobile phone data. Social Inclusion, 9 (2). DOI: 10.17645/si.v9i2.3839

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Supervised master's theses:

Eliana Solange Ortiz Gavela, 2020, (sup) Siiri Silm; Veronika Mooses, Comparing activity-space based segregation methods: a study with GPS data, University of Tartu, Faculty of Science and Technology, Institute of Ecology and Earth Sciences

Kristin Kesküla, 2017, (sup) Veronika Mooses, Asukoha ja lojaalsuse mõju ostukoha valikule: Veeriku Selveri juhtumiuuring (The impact of location and loyalty on the selection of shopping centre: the case study of Veeriku Selver), University of Tartu, Faculty of Science and Technology, Institute of Ecology and Earth Sciences

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Marcińczak, S., Mooses, V., Strömgren, M., Tammaru, T. (esitatud). Determinants of Immigrant-Native Segregation at Multiple Spatial Scales in Europe. Journal of Ethnic and Migration Studies.

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Eliana Solange Ortiz Gavela, 2020, (juh) Siiri Silm; Veronika Mooses, Comparing activity-space based segregation methods: a study with GPS data (Tegevusruumipõhise segregatsiooni hindamise meetodid GPS andmetel), Tartu Ülikool, Loodus- ja täppisteaduste valdkond, Ökoloogia ja maateaduste instituut

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2016–…	H2020 SmartEnCity – tarkade ja CO_2 neutraalsete linnade poole Euroopas. Projekti täitja.

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