Social segregation around the clock in the Paris region (France)

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ABSTRACT

While social scientists have invested a lot of energy in exploring the uneven distribution of social groups in the city, they have surprisingly limited their efforts to investigating social segregation at the place of residence. The present paper investigates social segregation over the 24 h a day in the Paris region, taking into account how social groups move within a city throughout the day.

From a large and precise daily travel survey carried out in the Paris region (EGT 2010) among 25,500 respondents aged 16 or over, we have computed segregation indices and maps hour by hour from respondents' educational and socioprofessional indicators. We then observed that social segregation within the Paris region decreases during the day and that the most segregated group (the upper class group) during the night remains the most segregated during the day. We also explored how the co-presence between various social groups evolves throughout the day. Finally, we highlighted some large variations in districts' social composition over 24 h: districts with similar social composition during the night can differ deeply in their social composition during the day-time because of socially selective daily trips.

Exploring social segregation around the clock helps in considering more dynamically place effects on individual behavior and targeting areas to implement interventions more connected with the real city rhythm.

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1. Context

1.1. Research justification

The present paper investigates social segregation (defined as the uneven spatial distribution of social groups) over the 24 h a day within a metropolitan area, taking into account how social groups move within a city throughout the day. At least three reasons support the importance of exploring social segregation around the clock. Firstly, neighborhood attributes and neighborhood effects both have to be considered dynamically, taking into account population daily mobility. When moving, inhabitants may indeed be exposed to different neighborhoods and social contexts and, conversely, transform the social context of inhabitants who do not move (Wong and Shaw, 2011). Education, employment, or health issues could then be related not only to residential segregation ("night-time" segregation), but also to "day-time" segregation. Secondly, public and municipal actors may find it more efficient to implement interventions in areas with high concentrations of specific social groups not only during the night but also during the day. Crossing information about night-time and day-time segregation would then be useful for every action aiming to reduce social inequalities in the city. Finally, social segregation around the clock may also contribute to the enhancement of urban models of social structures and dynamics. Debates

about "fragmented cities" (Borsdorf and Hidalgo, 2009) or "*villes éclatées*" (May et al., 1998) integrate notions such as social and spatial cohesion and exclusion, but few quantitative analyses consider how social groups mix or are isolated in a city on a daily basis.

1.2. A brief combined review of segregation and daily mobility

Social scientists have invested a lot of energy over a number of decades into measuring properly the uneven distribution of social groups in the city. For a long time, scientific debate about segregation was focused on the bias and redundancy of segregation indices (Hornseth, 1947; Jahn et al., 1947; Williams, 1948; Jahn, 1950; Cowgill and Cowgill, 1951), on the weaknesses of the index of dissimilarity (Cortese et al., 1976; Taeuber and Taeuber, 1976; Massey, 1978; Massey and Denton, 1988), or on the development of spatially-aware measures of segregation (Grannis, 2002; Reardon and O'Sullivan, 2004; White, 1983; Wong, 2005). However, they have, surprisingly, limited their efforts to investigating segregation at the place of residence and have not explored the geography of social groups during the day-time. Even if the term "occupational segregation" was introduced earlier in the literature, it was only to designate either the uneven residential distribution of occupation groups (Duncan and Duncan, 1955) or the uneven distribution of sociodemographic groups (mainly male versus female) among occupational categories without spatial consideration (Abrahamson and Sigelman, 1987). While census data could have been used to measure workplace segregation, empirical studies on workplace segregation are scarce and relatively new

(Hellerstein and Neumark, 2008; Åslund and Skans, 2010). Investigating the characteristics of co-workers at an establishment-level in US or Swedish cities from employment databases, these studies produced valuable information on ethnic segregation patterns but did not provide information on the day-time localization of social groups within the city. In that vein, the study by Ellis et al. (2004) has to be mentioned. The authors compared levels of residential and work tract segregation for native and immigrant groups in Los Angeles; however, focusing on the working-class population, they do not consider people that are not working nor the effect of other kinds of daily activity (leisure, shopping, etc.).

For a long time, studies about day-time population (Chapin and Stewart, 1953; Foley, 1952, 1954) have been ignored in segregation literature. Mechanisms of segregation and of daily mobility could yet benefit from being combined: daily mobility is socially differentiated according to socio-demographic characteristics, as highlighted by Orfeuil's daily mobility state of the art (Orfeuil, 2002), and can either promote interactions between different social groups, as suggested in more and less recent literature (Park, 1925; Urry, 2002), or, on the contrary, reinforce avoidance practices or affinity aggregation of certain social groups (Chamboredon and Lemaire, 1970; Authier, 1993).

Only recently, several authors have explored urban segregation from an activity-based approach. For this purpose, time-geographic analysis methods have been developed to compare the shapes of activity spaces for members of distinct social groups. This first type of work focuses on the socio-spatial isolation of agents, as developed by Lee and Kwan (2011) for Koreans in Columbus (USA). Another group of papers takes into account the social characteristics of places crossed in people's activity spaces. They assess the exposure of members of different social groups to other social groups in respect of the spaces in which they conduct their everyday life. For example, to study ethnic segregation in southeast Florida, Wong and Shaw (2011) proposed an exposure measure using a travel survey to implement activity spaces and census data to socially qualify the visited neighborhoods. With the same kind of approach and using information on daily mobility from a health survey, Krivo et al. (2013) showed for socioeconomic and ethnic groups in Los Angeles that residents of both advantaged and disadvantaged neighborhoods experience social isolation when they travel through the city to conduct their daily activities. Nevertheless, these studies face the limitation of considering the social composition of crossed neighborhoods in the activity spaces according to resident characteristics and not their variations during the day. Transcending this limitation, recent studies have taken into account the dynamics of space by using large travel surveys or mobile phone datasets. Palmer (2013), for example, proposed a range of "activity-space segregation indexes" derived from well-tested residential segregation indexes but taking into account individual daily schedules and the time spent in the different census tracts. In a similar vein, Silm and Ahas (2014) described the spatiotemporal variation of segregation indexes computed from a mobile phone dataset for Russians living in Tallinn (Estonia). They identified significant differences in the level of segregation of the group according to the hour of the day, weekdays and weekends, and seasonal rhythms. Finally, Farber et al. (2015) proposed a reproducible exposure measure based on potential opportunities for social contact for members of different social groups by taking into account the intersection of their spatiotemporal activity patterns.

1.3. Objectives

Following a similar activity-based approach, the present paper explores social segregation around the clock in the Paris region using a large daily travel survey carried out in the Paris region among 25,500 respondents aged 16 or over. Four objectives can be distinguished here.

First, we aim to compare classic measures of "night-time" segregation (residence-based) with measures of "day-time" segregation (activity-based). The previous few papers dealing with this question

underlined that ethnic segregation decreases significantly during the afternoon in the capital of Estonia (Silm and Ahas, 2014) or when comparing work tract segregation and residence tract segregation in Los Angeles (Ellis et al., 2004). Do we observe similar findings about social segregation in the Paris region? Are there some specific periods during the day in which segregation is especially low or high?

The second objective of the paper is to identify the most segregated group, not only during the night, but also during the day. While urban segregation and deprivation are often linked in many public policy statements, some studies in Paris (Préteceille, 2006) and in other European cities (Musterd, 2006) have shown from residential-based data that the upper class is the most segregated group. Do daily trips, which are socially differentiated in terms of distance and type of activity, also give the upper class "the award" of the most segregated group during the day?

In a third step, we explore social segregation over 24 h from the co-presence of various social groups in the same urban areas. Term of "co-presence" - defined as simultaneous presence of individuals in the same place - has been preferred to the term of "interaction" (often used in some quantitative segregation studies) since spatial proximity between social groups does not imply necessarily social contacts or real interactions (Chamboredon and Lemaire, 1970). Qualitative work on the French bourgeoisie showed how the dominant class promotes living with peers and deliberately keeps other social classes away from its favorite places (Pinçon and Pinçon-Charlot, 2007). How strongly does the upper class keep its distance from other social groups when they carry out their activities during the day, and do these behaviors extend to other social groups? Do probabilities of co-presence between upper and lower class members remain similar over a 24 hour period? At what time co-presence probabilities are the lowest?

Lastly, our analysis of social segregation around the clock aims to pinpoint areas with substantial changes in their population's social composition over 24 h. While spatial distribution of social groups in the Paris region, organized around a west/east division, is now fairly well known (Préteceille, 2006), some studies focusing on particular neighborhoods have underlined how far visiting populations may differ socially from resident populations and how strongly the non-resident populations may contribute to the social labeling of some areas - for example, in the case of the *Château-Rouge* neighborhood in Paris (Chabrol, 2011). How do socio-spatial divisions, traditionally observed from residential-based data, evolve around the clock?

2. Data

2.1. Household travel survey

The *Enquête Globale Transport* (EGT) is a large household travel survey carried out every ten years in the Paris region (Ile-de-France) since 1976. In the present paper, we used the last edition (EGT, 2010, STIF-OMNIL-DRIEA) which took place during two periods: from October 2009 to May 2010 and from October 2010 to May 2011 (i.e. over 16 months of surveys). This survey provides a large amount of information on the daily mobility of inhabitants aged five and older, in addition to household and individual characteristics.

About 15,000 households were selected and surveyed about their trips on weekdays (Monday to Friday) and 3000 about their trips at weekends (Saturday or Sunday). Data from more than 43,000 respondents (and 18,000 households) were collected, with a total of 143,000 trips.

In the present research, we took into account respondents aged 16 years or over, considering that younger people were not sufficiently autonomous in their daily mobility (Massot and Zaffran, 2007). Of the 26,312 respondents during the week aged 16 or over, 813 were excluded due to missing data in their daily mobility schedule or in socioprofessional or educational status. The final sample contains