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A grounded visualization approach to explore sociospatial and temporal complexities of older adults' mobility

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ABSTRACT

In the past decade, there has been an increasing interest in older adults' mobility.

Most often, mobility is measured quantitatively as physical movement (e.g. physical activity) or travel behavior (e.g. trips, modes, and distances). There is a need to integrate both quantitative and qualitative data over time to visualize both context and content in a spatial and temporal dimension and discover patterns and explanations for their underlying processes. We aim to address this gap by demonstrating how a grounded visualization approach can be used to explore sociospatial and temporal complexities of older adults' mobility. We present two cases of active community (urban) dwelling older adults with low incomes (age > 65) who live in Metro Vancouver, Canada, over a period of 4 years. Geographical Position Systems (GPS) (QStarz Datalogger BT-Q1000x) data is used to capture the destinations participants travel to and the routes they take to get there. Survey data provides socio-demographic characteristics and neighborhood environments. Interview data capture perceptions, attitudes, and motivations of destinations and route choices over time. Integration of the methods identified the following themes: spatial perceptions of neighborhood, consistency in travel patterns, changes in physical health, familiarity with place and access over time. Our grounded visualization approach demonstrates how georeferenced qualitative data can be combined with quantitative spatial data to provide a deeper understanding of the complexity of older adults' mobility experiences over time. Findings illustrate that time is a necessary component of older adults' engagement with place; familiarity influences spatial perceptions of local and distant 'neighbourhoods'; and older adults prioritize destinations that allow them to engage in multiple activities. By integrating methods we are able to gain a better understanding of challenges faced by older adults at multiple systems levels, and uncover resources and assets available to remediate them.

1. Introduction

In the past decade, there has been an increasing interest in older adults' mobility. Mobility is the ability and the opportunity to physically move oneself, either independently or by using assistive devices or transportation, to get to places one wants or needs to go (Mollenkopf et al., 2011; Webber et al., 2010). Mobility enables older adults to maintain their physical health, independence and participation in the society (Webber et al., 2010). In gerontology, mobility has predominantly been understood in functional terms, i.e., as a physiological ability to move (Pahor et al., 2014). Functional mobility is most often measured through the use of self-report surveys, or accelerometers. Transport and geographical research has emphasized the objective travel behavior patterns of older adults' mobility, typically trips per day, modes (both motorised and no-motorised) and distance travelled (Collia et al., 2003; Su and Bell, 2009). Mobility in this sense can be defined as movement in time and space and assessed using Geographical Positioning Systems (GPS) and travel diaries (Jankowska et al., 2015). In recent years, the 'mobility turn' has captured the subjective dimensions of mobility by providing a critical analysis of the term mobility. For

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instance, Cresswell (2010) and Frello (2008) argue that in addition to physical movement – getting from one place to another, mobility is characterized by the representations of movement that give it a shared meaning and the experiences and embodied practice of movement. Qualitative methods are used to highlight the 'embodied and practiced' elements of older adults' mobility that elude quantitative methods (blinded for review; Goins et al., 2014).

A vast number of mobility studies apply either quantitative *or* qualitative methods and demonstrate that individual level characteristics (i.e. physiological, motivational, cognitive or personality aspects) as well as elements of built and social environments influence mobility (Chaudhury et al., 2016; Chudyk et al., 2015; Hanson et al., 2012; Hirsch et al., 2014; Ottoni et al., 2016; Rosso et al., 2011; Yen et al., 2009). For example, from a physiological point of view, demonstrating that physiological ability is needed to generate movement and to maintain a balanced upright position while moving (Rantanen, 2013). A transport and geographical perspective examines the neighborhood built environment, including features such as destinations, transportation and street layout, influence an older adults' opportunities to move about their environments (Frank et al., 2006; Van Cauwenberg et al., 2014). A social gerontologist perspective investigates the social environment, such as how social spaces, social relationships, and cultural milieus play a critical role in influencing older adults' mobility (Gardner, 2013; Guell et al., 2016; Mahmood et al., 2012; Ottoni et al., 2016). Finally, a subjective point of view captures older adults embodied experiences and practices of mobility (Goins et al., 2014) that affect judgments and actions over time (Franke et al., 2013; Ivory et al., 2015; Mollenkopf et al., 2011; Ziegler and Schwanen, 2011). However, most of these subjective studies have focused on driving reduction and cessation, showing that these processes are often associated with loss of independence, self-determination and spontaneity (Nordbakke and Schwanen, 2013).

In recent years scholars have applied interdisciplinary mixed-method approaches to assess mobility, such as qualitative GIS (Kemper, 2014; Kwan, 2016; Kwan and Ding, 2008). Qualitative GIS is not a singular method, but an approach that makes connections between the strengths of both qualitative and spatial research. This permits knowledge gained from one method to be clarified and developed through the use of another (Kwan and Knigge, 2006; Moran et al., 2011). Mobility studies that have used qualitative GIS as a research approach suggest that triangulating methods leads to more rich and vivid accounts of mobility behavior (Bell et al., 2015; Meijering and Weitkamp, 2016; Milton et al., 2015). For example, Milton et al. (2015) and Bell et al. (2015) found that visualising and drawing on maps provided a visual aid for discussions about the importance of participants' routine practices. This approach explored how older people define and interact with space.

Spatial data and qualitative data can be integrated and analyzed in a number of different ways (Kwan, 2016; Mennis et al., 2013). Grounded visualization is an analytic approach that is well-suited for mobility research as it aims to identify community features at multiple systems levels all while giving credence to research participants' own lived experiences (Knigge and Cope, 2006). Grounded visualization combines elements of grounded theory, a traditional qualitative analysis approach, with geovisualization, the visual representation and analysis of geographic data (Knigge and Cope, 2006). The combination of qualitative and quantitative data together with a commitment to iterative, reflexive rounds of analysis, enables research to be attuned to multiple subjectivities, truths and meanings. Knigge and Cope (2006) describe grounded visualization as an approach in which spatially referenced data are explored visually in different ways in order to discern new patterns, or trends. This process is inductive, iterative, and reflexive, like grounded theory. Grounded theory "involves a set of strategies, tools, and central principles that aid researchers in doing inductive, reflexive, and rigorous analysis of data" (Cope, 2009, p.647). Researchers are expected to go back and forth between multiple data sources, frequently re-turning to do more data collection as new themes emerge, new questions arise, and new concepts need clarification or validation (Charmaz, 2014). The role of iteration in analysis is not as a repetitive mechanical task but as a reflexive process that is key to sparking insight and developing meaning. Please see Knigge and Cope (2006) and Walker and Hanchette (2015) for examples of use of grounded visualization.

Researchers are **also** able to visualize context and content in a temporal dimension. This is significant as few GIS aging, mobility researchers have fully attended to the **temporal dimensions** of sociospatial phenomena (Kwan, 2013). The little research that has been done has shown that perceptions of mobility and neighbourhoods change over the course of the day, seasonally, annually and the lifecourse (Meijering and Weitkamp, 2016; Mennis et al., 2013; Milton et al., 2015; Schwanen et al., 2012). However, this data has been collected from a single time point and has not used multi-year data collection to assess change and/or consistency in mobility patterns and perceptions. The failure to focus on the temporal aspects of older adults' environment and mobility relationships treats older adults' transactions with their "environments, settings, or situations as merely contextual snapshots or temporally static episodes rather than frames of an ongoing environmental movie" (Golant, 2003, pg. 639). The social psychology and environmental psychology literature offers many theoretical insights into the pervasive role played by time in understanding human experiences. For example, time as a component of older adults' attachment to place where familiarity with place establishes itself through length of residence in the community (Rowles, 1978, 1983). Familiarity with the physical and social structure of the neighborhood is important for older adults. Familiarity can facilitate adaptive strategies for older adults with mobility impairments and confer a sense of belonging, independence and subjectively experienced autonomy (Wiles et al., 2012; Ziegler and Schwanen, 2011). Mobility, much like place attachment, is not a static state but rather a process that continues throughout life. For instance, Bell et al. (2015) reported that an older adults' current place preferences are shaped by the cumulative influence of past place experiences. Experienced life course trajectories shape and influence how individuals adapt and react to challenging environmental experiences (Elder, 1998). Yet mobility research and environmental gerontology theories generally do not incorporate a temporal line of inquiry (Golant, 2003).

In addition to time, income is recognized as an important factor that influences mobility (Yen et al., 2009). Specifically, older adults with low incomes have a greater susceptibility to limited mobility (both physiological ability and travel behavior) than those with higher incomes (Chetty et al., 2016; Koster et al., 2006; Nordstrom et al., 2007). This susceptibility puts them at an increased risk for decreased individual capacity and increased risk of morbidity, poor physical function and incident mobility impairment over time (Huisman et al., 2003; Koster et al., 2006; Shumway-cook, Ciol, Yorkston, Hoffman and Chan, 2005).

We aim to advance mobility research by utilizing a grounded visualization approach to integrate quantitative (GPS) and qualitative (interview) methods, **and add the dimension of time**. We use two cases to illustrate how a grounded visualization approach using GPS, accelerometer, survey and interview data can be integrated to create visual representations of the sociospatial and temporal complexities of older adults' mobility experiences (e.g., where they travelled – destinations/routes; patterns of travel – change and consistency). Importantly, we do so while giving