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On the complexity of finishing a crossing on time: Elderly pedestrians, timing and cycling infrastructure

Ugo Lachapelle [a,*], Marie-Soleil Cloutier [b]

[a] Département d'études urbaines et touristiques, École des sciences de la gestion, Université du Québec à Montréal, Case postale 8888, Succursale Centre-Ville, Montréal, QC H3C 3P8, Canada
[b] Centre Urbanisation Culture Société, Institut National de la Recherche Scientifique, 385, Sherbrooke Est, Montréal, QC H2X 1E3, Canada

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ABSTRACT

Aging population and reductions in car use by seniors have the potential to increase active transportation rates. While there are associated health benefits to this potential shift, there are also higher risks for elderly pedestrian injuries, especially at street crossings. This naturalistic study compares street crossing behaviors of different population age groups in large Québec cities through observational data, situational characteristics and environmental characteristics of location. We assess if observed crossings could be completed safely within the allocated time. Street crossing observations on 2073 pedestrians was gathered at 135 signalized crossings during a four-month period in the summer of 2013. Mixed effect logit models are used to assess the individual, contextual, behavioral and environmental correlates of street crossing ending. Differences in age groups and other correlates are assessed for their association with the type of street crossing ending (on red light, on red hand or on both). In multivariate models, older age did not have an impact on finishing crossing on time, but many factors associated with older age were: having a walking aid, hesitating, and slowing down mid-crossing. Longer "white man silhouette" timing was also associated with reduced odds ratio of failing to finish crossing on time. The presence of cycling infrastructure increased those odds. Without walking, many elders will experience decreasing level of access. In neighborhoods with high concentrations of elderly populations, providing shorten crossing distance or longer crossing timing, may increase the convenience of walking for elderly populations. Longer signal timing may also be warranted in locations where cycling infrastructures were added to account for the increased level of difficulty.

1. Aging pedestrians: a growing road safety issue

Many challenges come with population aging in North American cities. Road safety for senior pedestrians is one of them: as they lose the ability to drive, these residents still must fulfill basic needs. This precarious equilibrium between autonomy (to be able to do things by themselves) and fear of the street environment should be part of planners' concerns if increased active transportation is an objective.

* Corresponding author.
E-mail addresses: lachapelle.ugo@uqam.ca (U. Lachapelle), marie-soleil.cloutier@ucs.inrs.ca (M.-S. Cloutier).

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Unfortunately, aging pedestrians have been overrepresented in crashes; up to 50% of all injured pedestrians in OECD countries are seniors (International Transport Forum, 2012). They are also typically more severely injured in road crashes (Siram et al., 2011) and stay longer in hospitals (3–5 times more than injured pedestrians aged between 15 and 64 years old) (Abou-Raya and Elmeguid, 2009; Loo and Tsui, 2009). These preoccupying observations have led many researchers to study risk factors associated with this vulnerable population group. Results illustrate that the seniors' individual characteristics (cognitive and physical capacities), the road environment and the interactions between the two explain their greater road-related risk.

Through the process of aging, many changes in cognitive capabilities have been observed. These may alter senior's decision-making process when crossing the street, a major task in many walking journey. For example, loss of concentration or other cognitive assets may alter their ability to choose a safe gap in traffic (Oxley et al., 2005; Dommes and Cavallo, 2011), to overestimate incoming vehicle speed (Lobjois and Cavallo, 2009) or their own walking speed when they do choose to cross (Holland and Hill, 2010).

Other physical impairments such as loss of vision, hearing or muscle and articulation pain will also contribute to walking's arduousness (Huguenin-Richard et al., 2014). Such situations may make elderly pedestrians at best uncomfortable to travel by walking, and at worst, confined to their immediate environment without the ability to access neighborhood destinations. As a result of this unease, senior pedestrians may divert route and choose to cross more often at signalized intersections deemed safer. Nevertheless, there are more seniors injured at intersections than any other pedestrian age group. For example, an estimation based on crash data in Montreal, Canada for a seven-year period (2003–2009) showed that for seniors (65 years old and over), 85% of injuries, including fatalities, occurred at signalized intersections, while this share was of 60% for all pedestrians, regardless of age group (Cloutier et al., 2014; Auger et al., 2015).

Beyond individual variables, characteristics of streets and intersections where crossing takes place have also been studied for their influence on pedestrian crashes, but also on pedestrian behaviors, including those of seniors. Characteristics such as crossing width or crossing time have been related to higher risk of injury for senior pedestrians (Gates et al., 2006; Leden et al., 2006; Dumbaugh and Rae, 2009; Romero-Ortuno et al., 2010; Rastogi et al., 2012). Other results are not as conclusive. Parked vehicle at the curb had contradictory effects: while Tom and Granié (2011) show that pedestrians display more cautious crossing behavior when there are no parked vehicles nearby, Yannis et al. (2013) found that the presence of illegally parked vehicles at mid-block crossing makes the pedestrians more careful because of reduce line of sight. Similarly, the number of pedestrian crossing simultaneously has been hypothesized as an important factor in red light violation, but empirical results vary. Authors have found both positive relationships (i.e. more pedestrians crossing together was associated with more red light violation) (Rosenbloom, 2009; Brosseau et al., 2013) and negative ones (Ren et al., 2011).

Not all street features have been studied in details. Because many cities are currently developing cycling infrastructures, understanding how streets designed for use by multiple modes can influence street crossings for pedestrians will help identify how their safety and comfort can be improved. While there is considerable growth in the presence of on street cycling paths, literature on their impacts is lacking. A few reasonable hypotheses can nonetheless be made. Where cycling infrastructure is added, intersections become more complex because various incoming vehicles arrive at different speeds, with different trajectories. Oncoming traffic from multiple directions may be more of an issue for older pedestrians with slower reflexes. Cities need to know how to adapt intersections where a cycling infrastructure has been added.

As the existing literature shows, there are a number of issues for which data is inconclusive and others for which there is little to no research. A better understanding of the interaction between pedestrians and the crossing environment is needed for planners to identify "best practices" and create environments that can be used safely and pleasantly by pedestrians of all ages. The purpose of this paper is to fill this gap by assessing if crossing can be completed safely in the allocated time by adults and senior pedestrians. Our main objective is to determine the individual, situational, behavioral and environmental correlates of finishing a crossing when signals already indicate that pedestrians should no longer be on the street (i.e. red light, red hand or both). We use these three outcomes to cover the variety of assessed signalized pedestrian crossing intersections in multiple cities. While a pedestrian still on the street after a light has turned red is not automatically at high risk of being run over by cars, our logic is that such situation can be indicative of unfavorable environments for elderly pedestrians to walk in, creating insecurities, stress and discomfort, and ultimately reducing the likelihood of walking on a frequent basis.

2. Observations of unsafe street crossing: a naturalistic experiment

In order to assess unsafe street crossing behavior as an outcome, information on individual, behavioral, situational (at the time of crossing) and environmental correlates must be observed. The organization of these concepts in our research is presented in Fig. 1. As seen in the previous section, existing research have identified some of these correlates, but seldom studied them jointly using a naturalistic research design. We expect that four groups of factors will be associated with the likelihood of not completing a crossing on time. To be clear, this study does not assess if a pedestrian chose to cross, but rather if observed crossing were conducted safely while respecting the law.