SOCIAL NETWORK EFFECTS ON ATTITUDES ABOUT PEDESTRIAN STREET CROSSING BEHAVIOUR: PRELIMINARY FINDINGS

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ABSTRACT

The effectiveness of interventions to improve pedestrian safety, whether involving engineering, education, or enforcement, is limited by the behavior of the public in response to the interventions. It is not difficult to imagine that the behavioral response of an individual to engineering and educational road safety interventions may be at least partially explained by demographic characteristics. It is also plausible that membership and interactions in a social group influences an individual's behavior and attitudes about road safety and response to such interventions. This paper describes preliminary findings from a project that is employing a mixed survey framework of in-person gatherings and online respondent driven sampling surveys to explore how demographics, pedestrian safety education and social group membership and interaction explain an individual's behavior and attitudes related to crossing a signalized intersection as a pedestrian in different physical and travel settings. This paper describes the findings from small size in-person samples. Multinomial logit modeling will be applied to predict stated pedestrian behavior. The results will shed light on pedestrian attitudes about traffic signal design and operation as well as identify how to most effectively improve pedestrian safety through education and social group interaction.

1. BACKGROUND AND OBJECTIVE

Providing for safe crossing of roadways by pedestrians is an important element of road engineering. Crashes involving pedestrians constituted three percent of all people injured in traffic crashes and pedestrian deaths accounted for fourteen percent of all road fatalities in the US in 2011 (NHTSA 2011). Crashes and conflicts (near crashes) between pedestrians and motor vehicles tend to be higher at locations with longer crossing distances (Islam *et al.* 2014). The probability that a pedestrian crossing at a signalized intersection experiences a conflict with a motor vehicle is higher when the pedestrian is jaywalking (crossing outside the crosswalk or during the red phase) than when the pedestrian crosses during a walk signal (FHWA 2014). This is not surprising, but it does draw attention to the importance of pedestrian crossing behavior in explaining pedestrian safety experience.

These facts suggest that in order to reduce opportunities for vehicle – pedestrian crashes it is necessary to change the behavior of both pedestrians and drivers. Effecting changes in pedestrian and driver behavior requires first understanding their behavioral choices – what drives the decisions they make when they cross the street or navigate through an intersection with pedestrians? For example, do members of a particular social group tend to behave similarly to one another when they act as a pedestrian or vehicle driver, and do the opinions of other members of the group influence their propensity to change their behavior in response to education of pedestrian safety?

The objective of this research is to learn more about people's attitudes about pedestrian behavior and pedestrian safety, and how these attitudes are affected by the social networks to which an individual belongs. We will survey individuals about their stated behavior choices regarding crossing signalized intersections in the context of real and virtual social networks. The proposed survey framework will help to identify factors that explain stated behavior choices and changes in those choices in response to safety education and discussion within a social network. The project will also learn if the social network connections themselves help explain this stated behavior and response to specific safety educational interventions. This "big data" framework will compare observations made at a small scale (dozens of observations) with others at a very large scale (thousands of observations). The framework allows for collection of both quantitative and qualitative data about social network attitudes about pedestrian behavior.

2. RESEARCH CONTRIBUTION

Interventions aimed at improving road safety are often categorized into "the four E's": Engineering, Education, Enforcement and Emergency response. Regarding pedestrian safety, Martin (2006) described traffic engineering interventions designed to influence the pedestrians themselves or drivers of motor vehicles. Many have emphasized that modification of the built environment can substantially reduce the risk of pedestrian-vehicle crashes (Retting *et al.* 2003; Zahabi *et al.* 2010, 2011). Zhou *et al.* (2007) presented interventions to influence pedestrian behavior including separation of pedestrians from vehicles and measures that increase the visibility and conspicuity of pedestrians. Interventions have also been targeted reducing vehicle speed to reduce the risk and consequences to pedestrians of a collision. Chen *et al.* (2013) found that signal related countermeasures have significant safety benefits compared to measures designed to alert drivers' cognitive attention.

Road safety education interventions to reduce the risk of pedestrian injury have focused mainly on strategies to teach road users how to safely navigate the road environment, such as community-based campaign and school-based training programs to promote desirable attitudes and behaviors especially in school children (Rivara *et al.* 1991; Boyce and Geller, 2000; Hotz *et al.*, 2004; Turner *et al.*, 2004). A review of trials by Duperrex *et al.* (2005) found that pedestrian safety education can improve

children's road safety knowledge and their observed road crossing behavior, but may be need to be repeated at regular intervals. McComas *et al.* (2002) used a desktop virtual reality (VR) program to determine whether children can learn pedestrian safety skills and found that VR intervention can significantly improve crossing behavior in the suburban school children compared to urban school children. Very few studies consider the effect of education on adult pedestrians.

Enforcement of road traffic laws to improve road safety is primarily aimed at motorists, as there are comparatively fewer pedestrian traffic regulations to enforce. In particular, enforcement programs against speeding, red light, stop sign and cross walk violations have been implemented in many locations (Cicchino *et al.* 2014). In addition to traditional, patrol-based enforcement programs, a large number of researchers have focused on programs of camera enforcement (*e.g.* red light camera and speed camera) (MacCartt and Hu 2013; Retting *et al.* 2008; Wilson *et al.* 2010), finding these programs can significantly reduce violations of traffic law. Van Houten and Malenfant (2004) found that high-visibility enforcement of pedestrian right-of-way laws in Miami Beach increased the percentage of drivers yielding to pedestrians. Savolainen *et al.* (2011) used a targeted pedestrian enforcement in the city of Detroit, Michigan, to reduce the rate of pedestrian traffic violations. This enforcement program was found to reduce violations up to 17% during the enforcement program.

Emergency response services are very important in handling and minimizing the impacts of traffic accidents and for saving human lives. Crash victims have a better chance of recovery, or avoiding death, if emergency services are notified quickly and accurately about the crash (Clark and Cushing, 2002). Noland and Quddus (2004) pointed out that improvements in medical care and technology can also significantly reduce traffic fatalities. Sanchez-Mangas *et al.* (2010) found that a ten minute reduction in emergency response time could lead to a 30 percent reduction in traffic accident fatalities in Spain. Recently, Kepaptsoglou *et al.* (2012) developed an efficient emergency response model for responding to traffic accidents, combining a location model with a genetic algorithm.

The success of engineering solutions, education interventions, advanced technology implementation, and the enforcement of rules depends on the road users' response in changing their behaviors. Islam *et al.* (2014) showed that pedestrian-vehicle crashes tend to be higher at locations with longer crossing distance. Pedestrian response to different intervention strategies have been widely investigated (Zahabi *et al*. 2011). Ellis and Van Houten (2009) found in a before-and-after comparison study that inexpensive engineering countermeasures could produce a significant reduction in crashes when introduced in addition to a public education and enforcement program focusing on pedestrian safety. Another before-and-after comparison study by Zhang *et al.* (2013) evaluated the effectiveness of an education campaign for improving pedestrian safety and found that roadway safety on campus improved after the campaign and the improvement was most significant for the site closest to the location where the majority of campaign activities took place.

Considering the influence of social network information in transportation research is relatively new and has been studied in modeling mode choice and travel behavior. Ronald *et al.* (2009) developed a model combining social and spatial networks for investigating and predicting travel behavior. Schwanen (2008) demonstrated the relevance of social networks to travel behavior and concluded that social networks provide an important resource for implementing daily activities within a given space-time constraint. In addition to modeling travel behavior, social networks could be a useful tool for promoting transportation safety. The individuals in a social network can interact and share pedestrian safety interventions with others in the network and can influence them to improve their street crossing and yield to pedestrian behaviors.

Considering the research described above, this project will investigate potential for using social networks to influence pedestrian street crossing behavior to enhance the potential for success of interventions aimed at improving pedestrian safety in urban areas.

3. SURVEY METHODOLOGY

Our Study design is answering the following specific research questions:

1) How does social network association affect people's perceptions of when it is safe to cross the street at a traffic signal?
2) How does social network association affect people's response to information about pedestrian safety?
3) How does social network association affect attitudes toward various pedestrian signal phasing options?
4) How does a social network discussing statistics about pedestrian safety at traffic signal crossings affect participants' perceptions about the safety of crossing the street at a signal?
5) What reasons do participants provide for varying pedestrian crosswalk behavior?

Our study concept is a collaborative effort between researchers at the University of Connecticut and a faculty member and students at Manchester Community College. Students from Manchester Community College Communication classes (as part of their course credit) are serving as the starting point for participation in the study. Students assisted with pilot testing the surveys. The instructor (Dr. Townsend) worked their involvement into the course objectives.

Students working in pairs or groups of three asked participants in their social networks or asked a group to which they belong (*e.g.*, community group, senior center group, club, or organization) to devote about 60 minutes of time to participate in a focus group survey. These groups were targeted to consist of about 25 people each. Surveys were conducted in four intervention groups, each completing the same surveys, but receiving a different combination of interventions consisting of education and group discussion, including a group receiving no intervention. Table 1 shows the program for each intervention group; the components are described in more detail below. The survey form is provided in the Appendix.

Table 1 Intervention Group Programs

Intervention Group 1	**Intervention Group 2**	**Intervention Group 3**	**Intervention Group 4**
1. Demographic survey 2. Survey 1 3. Education 4. Survey 2	1. Demographic survey 2. Survey 1 3. Discussion 4. Survey 2	1. Demographic survey 2. Survey 1 3. Education 4. Discussion 5. Survey 2	1. Demographic survey 2. Survey 1 3. Survey 2

Demographic Survey: This is a brief survey to gather demographic data about each participant, including sex, age, racial/ethnic identifier, town of residence, education level and general income level (by category). We also asked questions about the respondent's experience with walking as a travel mode, both when growing up and where they live now, as well as safety history as a pedestrian and as a vehicle occupant.

Survey 1: We show participants a series of four approximately one-minute videos of street scenes showing a pedestrian crosswalk at a traffic signal and imagine that they need to cross the street at that

crosswalk. These videos were generated using the VISSIM traffic simulation software package. These scenes represented four combinations of low and high vehicular volume (300 and 700 veh/h/lane) and crossing two or four lanes of traffic. We asked participants to indicate when during the video they would cross the street. After each video, participants were asked to offer open-ended comments about the scene and about their attitudes about crossing signalized intersections as a pedestrian.

Education: A meeting facilitator provides a two sided flyer summarizing pedestrian behavior and safety facts to participants.

Discussion: A meeting facilitator moderates a 20 minute discussion about the information presented (for Intervention Group 1), about participants attitudes about their responses to the crossing situations presented in Survey 1 (for Intervention Group 2) or both (for Intervention Group 3).

Survey 2: This is the same as Survey 1, but with the video scenes presented in a different order. This second survey helps to learn how participants change their responses after receiving and/or discussing the information provided. Intervention Group 4 provides a control to learn about random changes in participant response due to participating in the experiment.

4. ANALYSIS METHODOLOGY

We are still conducting the surveys and anticipate completing them by late winter 2016. Once the survey data are collected, the analysis will consist of multinomial logistic regressions to analyze the categorical responses describing pedestrian crossing behavior obtained from the sampling surveys as a function of participant characteristics. We will incorporate social connections via a network whose edges have weights that reflect the existence and strength of the social connections. Wasserman and Pattison (1996) discussed logit-type models for data on a social network using Markov random graphs and generalizations of stochastic block models. Butts and Carley (2001) describe logistic regression on a network, using the *netlogit* function in R. We follow the notation and description in Anderson *et al*. (1999).

A social relation is defined on a set of subjects N = {1,…,g}, and measures how these subjects are linked to each other. A dichotomous social relation X is a set of ordered pairs of subjects (i,j) such that i and j have a relational tie, written as i → j. For a dichotomous relation, define a random variable X(i,j) =1 if i → j, and zero otherwise, so the odds of the tie is $P[X(i,j)=1]/P[X(i,j)=0]$ and a sociomatrix X is defined as {X(i,j)}. For instance, we may see that our subjects are linked by gender, or by age, or by socio-economic status. The family of models on a social network, p* includes the Markov random graphs (Frank and Strauss 1986) as well as the dyadic interaction log-linear model (Holland and Leinhardt, 1977, 1981), while feasible estimation via maximizing a pseudo-likelihood was discussed in Strauss and Ikeda (1990).

Based on data collected from the combined sample surveys, we propose to investigate the associations between categorical responses on pedestrian crossing behavior and subject and social network specific predictors. This will be done once before the “interventions” and once after the interventions. The results from our models will enable us to assess the effect of demographic variables as well as “social friendship” variables on behavioral patterns. A comparison of the results from the modeling post-intervention to the results pre-intervention will be extremely valuable to assess possible significant behavior modification through social interactions, thus providing useful action items in the area of pedestrian safety.

5. SUMMARY AND CONCLUSION

Numerous interventions have been implemented for improving pedestrian safety in the categories of Engineering, Education, Enforcement, and Emergency response. The effectiveness of these approaches has gone only so far in improving pedestrian safety. We know from recent research that pedestrians do not respond as we expect to various design decisions or interventions. Achieving further advances in pedestrian safety will require new research about how pedestrians and drivers respond to interventions as is proposed in this project. The rapidly expanding role of social networks in people's lives, especially online social networks, offers new opportunities for achieving these advances.

As noted above, we are still conducting surveys and expect complete them by late winter 2016. Results of analyzing the surveys will be presented at the conference and published in a follow-up paper. This research will learn about how social networks work with personal demographics to explain people's response to eductaion and discussion about pedestrian safety. This will potentially help us learn better how to take advantage of social networking to more effectively impart education and enhance pedestrian safety.

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APPENDIX: SURVEY FORM

Group Number: _____

Social Network Effects of Attitudes about Pedestrian Street Crossing Behavior

Co-Principal Investigators: Dr. John Ivan and Dr. Nalini Ravishanker of University of Connecticut and Dr. Rebecca Townsend of Manchester Community College (Sub-award # 76942)

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1. **How often do you:**
   a. Drive a car/truck?
      __Daily, ___Weekly but not daily, ___ Monthly but not every week, ___ Very seldom, ___ Never
   b. Ride a bicycle (during summer half of year)?
      __Daily, ___Weekly but not daily, ___ Monthly but not every week, ___ Very seldom, ___ Never
   c. Walk in built up areas of towns or cities?
      __Daily, ___Weekly but not daily, ___ Monthly but not every week, ___ Very seldom, ___ Never
   d. Use public transportation?
      __Daily, ___Weekly but not daily, ___ Monthly but not every week, ___ Very seldom, ___ Never
   e. Use a motorcycle or motorized scooter?
      __Daily, ___Weekly but not daily, ___ Monthly but not every week, ___ Very seldom, ___ Never

2. **In which region do you have the most familiarity with being a pedestrian (walking, using a wheelchair)?**
   ___City (urban area, mix of businesses and residential buildings, many people)
   ___Suburb (Compact area outside a city, mostly residential houses)
   ___Countryside (rural area with open space, lower population than suburbs)

3. **Where do you live now?**
   ___City (urban area, mix of businesses and residential buildings, many people)
   ___Suburb (Compact area outside a city, mostly residential houses)
   ___Countryside (rural area with open space, lower population than suburbs)

4. **What kinds of groups or organizations do you belong to? (religious, athletic, hobbies, political, civic, artistic, activist, musical, support…)**

5. **Please watch a series of 4 simulated videos that show a street intersection. Assume you need to cross the street from Point A to Point B. Assume the weather is fair and that you are unfamiliar with the location.**
   a. On the upper left part of the screen are the walk light and traffic light located at Point B.
   b. At the bottom of the screen is a timer.
   c. Choose when you would start to cross the street.
   d. Using your "gut reaction" response, write down the time (to the nearest second) at which you would start crossing.

Video 1	Video 2	Video 3	Video 4

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6. **What do you think is important for researchers to know about your typical street-crossing behavior?**

7. **Do you think your neighborhood is safe for walking? (circle one)**

1	2	3	4	5
Very Safe	Safe	Not Sure	Unsafe	Very Unsafe

8. **Have you been in a car/truck/bus accident involving Pedestrians (people walking, or using wheelchairs) or know someone who has?:**
   Yes_____ No_____

9. **In your opinion, does Pedestrian alcohol usage affect their street-crossing behavior?**
   Yes___ No___ Don't know___

10. **In your opinion, does Driver alcohol usage affect Pedestrians' street-crossing behavior?**
    Yes___ No___ Don't know___

11. **What role do you think *Pedestrians'* uses of cell phones plays in accidents?**

1	2	3	4
Major Role	Minor Role	No Role at All	I Don't Know.

12. **What role do you think *Drivers'* uses of cell phones plays in accidents?**

1	2	3	4
Major Role	Minor Role	No Role at All	I Don't Know.

13. **Does the location of the crosswalk affect people's street-crossing behavior?**
    Yes___ No___ Don't know___

PLEASE wait for further instruction before completing the rest of the survey. Thank you.

14. **Please watch a series of 4 simulated videos that show a street intersection. Assume you need to cross the street from Point A to Point B. Assume the weather is fair and that you are unfamiliar with the location.**
    a. On the upper left part of the screen are the walk light and traffic light located at Point B.
    b. At the bottom of the screen is a timer.
    c. Choose when you would start to cross the street.
    d. Using your "gut reaction" response, write down the time (to the nearest second) at which you would start crossing.

Video 1	Video 2	Video 3	Video 4

15. **What do you think is important for researchers to know about your typical street-crossing behavior?**

16. **Please indicate your gender:**
    a. Man
    b. Woman
    c. Transgender
    d. Prefer not to answer

17. **What is your current marital status?**
    a. Married
    b. Unmarried

18. **What is the number of children you have, or care for?**
    a. 0
    b. 1
    c. 2
    d. 3 or more

19. **What is your age?**
    a. 18 and under
    b. 19-25
    c. 26-45
    d. 46-65
    e. 66 and over

20. **What is your current employment status?**
_____ Student and full time employed
_____ Student and part time employed
_____ Student, not employed
_____ Full time employed
_____ Part time employed
_____ Unemployed for less than a year
_____ Unemployed for more than a year
_____ Retired
_____ Other, please specify_____
_____

21. **What is your education level?**
    a. I am still in high school
    b. I completed high school
    c. I have taken some college classes
    d. Associate's Degree
    e. Bachelor's degree
    f. Master's degree
    g. Doctoral degree

(Please go to the next page.)

22. **What is your household's combined yearly income before taxes?**

_____ Less than $10,000
_____ $10,000 to $14,999
_____ $15,000 to $24,999
_____ $25,000 to $34,999
_____ $35,000 to $49,999
_____ $50,000 to $74,999
_____ $75,000 to $99,999
_____ $100,000 to $149,999
_____ $150,000 to $199,999
_____ $200,000 or more
_____ I don't know

23. **What is your racial/ethnic identity? Choose all that apply.**

_____ African American/Black
_____ American Indian or Alaskan native
_____ Asian/Pacific Islander
_____ Caucasian/White
_____ Hispanic/Latino
_____ Other, please indicate:
_____

Thank you. This concludes the survey. Please help us learn more about pedestrians' behavior by sharing a link to the survey with your social network.