Accident Analysis and Prevention 98 (2017) 157–166

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

A study of pedestrian compliance with traffic signals for exclusive and concurrent phasing

John N. Ivan [a], Kevin McKernan [b], Yaohua Zhang [c], Nalini Ravishanker [c], Sha A. Mamun [a,*]

[a] Civil & Environmental Engineering, University of Connecticut, Storrs, CT, United States
[b] Division of Traffic Engineering, Connecticut Department of Transportation, Newington, CT, United States
[c] Department of Statistics, University of Connecticut, Storrs, CT, United States

ARTICLE INFO

Article history:
Received 24 December 2015
Received in revised form 23 August 2016
Accepted 3 October 2016
Available online 7 October 2016

Keywords:
Pedestrian
Traffic signal
Compliance
Exclusive
Concurrent
Binary regression

ABSTRACT

This paper describes a comparison of pedestrian compliance at traffic signals with two types of pedestrian phasing: concurrent, where both pedestrians and vehicular traffic are directed to move in the same directions at the same time, and exclusive, where pedestrians are directed to move during their own dedicated phase while all vehicular traffic is stopped. Exclusive phasing is usually perceived to be safer, especially by senior and disabled advocacy groups, although these safety benefits depend upon pedestrians waiting for the walk signal. This paper investigates whether or not there are differences between pedestrian compliance at signals with exclusive pedestrian phasing and those with concurrent phasing and whether these differences continue to exist when compliance at exclusive phasing signals is evaluated as if they had concurrent phasing. Pedestrian behavior was observed at 42 signalized intersections in central Connecticut with both concurrent and exclusive pedestrian phasing. Binary regression models were estimated to predict pedestrian compliance as a function of the pedestrian phasing type and other intersection characteristics, such as vehicular and pedestrian volume, crossing distance and speed limit. We found that pedestrian compliance is significantly higher at intersections with concurrent pedestrian phasing than at those with exclusive pedestrian phasing, but this difference is not significant when compliance at exclusive phase intersections is evaluated as if it had concurrent phasing. This suggests that pedestrians treat exclusive phase intersections as though they have concurrent phasing, rendering the safety benefits of exclusive pedestrian phasing elusive. No differences were observed for senior or non-senior pedestrians.

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1. Introduction

During the early half of the 20th century when the automobile began to displace the pedestrian as the dominant force on the streets, conflicts over who had the right of way were common. In the earliest days, the pedestrian was almost always given the right to cross where he or she pleased and attempts to control that freedom were often considered forms of tyranny. Eventually, the fact that the automobile was always the victor of any physical confrontation brought concessions from people on foot, and clever marketing campaigns created the "Jay-walker" – an uncivilized rube who meandered into traffic instead of crossing streets at the proper time and place (Norton, 2008). Furthermore, Baass (1989) noted that pedestrians are often treated by engineers as light, non-motorized vehicles and that "as traffic engineers, we must understand the traffic behavior of the pedestrian, who because of his inherent mobility, will always try to shorten distances and reduce waiting times, often without adhering to the highway code and disregarding the risks involved".

In an effort to understand pedestrian traffic behavior, this paper examines pedestrian compliance with two forms of pedestrian phasing at signalized intersections found in Connecticut. "Concurrent phasing" is where both pedestrians and vehicular traffic are directed to move in the same directions at the same time, while with "Exclusive phasing", all vehicular traffic is stopped and pedestrians are given their own signal phase to traverse the intersection across any of the approach legs. In concurrent phasing, pedestrians and vehicles share the same phase of the traffic signal, permitting longer uninterrupted phasing for vehicles and pedestrians. There are interactions between pedestrians and motor vehicles turning left or right across the crosswalk, but not between pedestrians and motor vehicles departing from approaches perpendicular to the

* Corresponding author.
E-mail address: md.mamun@uconn.edu (S.A. Mamun).

http://dx.doi.org/10.1016/j.aap.2016.10.003
0001-4575/Published by Elsevier Ltd.

crosswalk (other than right turns on red). Alternatively, an exclusive pedestrian phase stops vehicular traffic on all approaches to allow pedestrians to cross any leg of the intersection with no interaction with any vehicles (with the exception of vehicles turning right on red when permitted).

Exclusive phasing is often considered safer since potential conflicts between motor vehicles and pedestrians are theoretically avoided. Unfortunately, they are often less efficient for both motorists and pedestrians due to each having to wait while the other gets its appointed time to traverse the intersection, not to mention that cycle lengths must be longer to accommodate the pedestrian phase. As a result, exclusive phasing results in lower green ratios for vehicular traffic movements and complicates synchronization of signal timing along an arterial street. Another potential benefit of exclusive phasing is to reduce competition for green time at signals with very high pedestrian and turning vehicle volumes. This benefit, though, also depends on pedestrians complying with the signal indication.

Compliance, in the context of this paper, is based on the laws put forth by Sections 14-300 and 14-300b of the General Statutes of the State of Connecticut as revised January 1, 2013. The laws governing pedestrian behavior when crossing at signalized intersections pertinent to this study can be summarized as follows (CTDOT, 2009).

- At intersections where pedestrian control signals use the words "WALK" or "DON'T WALK," a pedestrian may only cross when indicated by the signal.
- At intersections where such signals do not exist, pedestrians may not cross against a red signal.
- Pedestrians may not cross at any place that is not a marked or unmarked crosswalk.
- Any pedestrian beginning their movement on a "WALK" signal or green light has the right of way over all vehicles until a curb or safety zone has been reached.
- Pedestrians may not cross an intersection diagonally unless authorized by a pedestrian-control signal or police officer.
- Pedestrians may not cross roads between adjacent intersections where pedestrian-control devices exist.

For this study, at signals with concurrent pedestrian phases, pedestrians are considered compliant if they both crossed within a crosswalk and began their movement on a green light corresponding to their travel direction. At signals with exclusive pedestrian phases, pedestrians are considered compliant only if they both crossed within a crosswalk and began their movement during the pedestrian phase prior to a flashing "DON'T WALK" light or similar warning. Zhang et al. (2015) which uses the same data set as this paper, found that interactions between vehicles and pedestrians were associated with compliance and that while signals with exclusive pedestrian phases were found to have fewer pedestrian-vehicle collisions overall, these collisions were more severe. Realizing that the benefits of exclusive signals depend upon pedestrians' willingness to comply with traffic regulations, this paper investigates whether or not there are differences between pedestrian compliance at signals with exclusive pedestrian phasing and those with concurrent phasing and whether these differences continue to exist when compliance at exclusive phasing signals is evaluated using the more relaxed compliance rules of concurrent signals (defined later in the paper). We also investigate whether differences between the two signal types continue to exist when counting only those pedestrians who crossed within the designated crossing areas, as opposed to those crossing outside of them.

2. Literature review

A 1977 study comparing exclusive signals, Leading Pedestrian Interval signals, and late release signals noted that pedestrian compliance at scramble signals, a variation of exclusive phasing in which pedestrians are permitted to cross the intersection diagonally, was very low and, indeed, the safety benefits of such signals may be negated by compliance issues (Abrams and Smith, 1977). Bechtel et al. (2004) compared intersections before and after the installation of exclusive signals and found that pedestrian violations increased after the exclusive signals were installed. Zegeer et al. (1982) compared traffic signals which had no pedestrian signals, concurrent pedestrian signals, and exclusive pedestrian signals. While pedestrian compliance was not noted, they did find that exclusive signals were safer than concurrent ones, especially in terms of collisions with turning vehicles. This effect seemed to fall off when pedestrian volumes went above 1200 per day, though the authors note that this may be due to a limited sample volume of exclusive signals. Garder (1989), after studying signals in Swedish cities, found exclusive signals to be an efficient safety measure as long as the number of pedestrians crossing against the light was low. An analysis of crashes in three Israeli cities found that exclusive signals were safer than concurrent signals when vehicle volumes were high, particularly if pedestrian volumes were low Where AADT values were below 18,000, though, little difference in pedestrian safety between signal types was observed (Zaidel and Hocherman, 1987). They also concluded that where pedestrian volumes are high, concurrent signals would likely function reasonably well in terms of safety due to pedestrians being a highly visible presence.

Orne (1959) found that pedestrian heads used in combination with traffic signals increased pedestrian compliance in both Bridgeport, CT and Lansing, MI by a small percentage. Mortimer (1973) reached a similar conclusion, observing that crossings against red lights were 10% lower in Detroit where pedestrian specific signals were installed. In addition, a hazard index created from the data suggested that there were 27% fewer avoidance maneuvers performed by pedestrian and drivers at the intersections with pedestrian signals. Since then, however, other studies have found no correlation between the inclusion of pedestrian heads and pedestrian compliance (Fleig and Duffy, 1967; Jacobs et al., 1968; Robertson and Carter, 1984). This is important to note because no concurrent signals with accompanying pedestrian heads were located for the study presented in this paper. From the studies mentioned above it appears that if the studied signals had pedestrian heads, either no difference or a slight increase in compliance might have been observed at the concurrent signals. In terms of safety, it is also interesting to note that Jennings et al. (1977) found that pedestrians tended to only look prior to crossings when "DON'T WALK" signals were lit and concluded that pedestrians may depend too much on the signals to keep them safe from harm.

Barker et al. (1991) studied pedestrian noncompliance in Australia, considering 33 intersections in two groups: one where pedestrians faced vehicular conflict and one where they did not. Only 9% of those who faced conflict crossed against the signal, whereas 49% of those who faced no vehicular conflict chose to cross against the signal. Akin and Sisiopiku (2000) divided compliance into temporal and spatial components and found that the temporal component (whether or not a pedestrian crossed against the signal) was heavily influenced by vehicle volume. Harrell (1991), though, observed pedestrians being less cautious on streets with higher vehicle volume than when crossing streets with low vehicle volume. He speculated that the reason for this may have been that streets with lower volumes allowed individual cars to travel faster, creating a larger risk for any unlucky pedestrian who might be struck.

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