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Exploring Jaywalking at Intersections

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Abstract

Jaywalking, aided by pedestrian distractions due to mobile phone use, is a significant contributing factor to pedestrian fatalities and serious injuries in Victoria. Although several studies have been conducted to understand the factors influencing pedestrians jaywalking at intersections, few are done in Australia. The aim of this study is to explore pedestrian jaywalking via video observation of an intersection in Melbourne, Victoria. It will provide useful information to develop suitable engineering, education or enforcement measures to reduce jaywalking behaviour at the intersections.

We found that jaywalking was prevalent at the intersection. We also observed herd jaywalking, whereby a pedestrian who jaywalked influenced other pedestrians to follow. We found approximately equal numbers of males and females among the jaywalkers. Using hand-held mobile devices and social interactions were the most frequent contributing factors observed among jaywalkers.

1. Introduction

The safe and efficient movement of pedestrians is important in many situations, including evacuation and special events (Dias et al.; 2014, Pender et al., 2012, Shiwakoti et al., 2015) or day-to-day activities that includes pedestrian flow at intersections (Diaz, 2002). Intersections are hazardous locations because of the large number of potential conflicts when different traffic streams converge (Tay, 2015; Barua et al., 2010; Kattan et al., 2009). Jaywalking, abetted by pedestrian distractions due to mobile phone use, is contributing to pedestrian fatalities and serious injuries in Victoria (Herald Sun, 2015; The Age, 2016; Transport Accident Commission, 2016). Around 196 pedestrians were killed on Victoria's roads over the past five years (VicRoads, 2016), with distraction and jaywalking emerging as a major factor. This indicates that jaywalking is indeed a pressing issue at the forefront of health and safety. However, if properly assessed and understood, appropriate countermeasures can be developed to prevent these behaviours and help save countless lives.

Jaywalking is a term commonly used to describe a pedestrian’s choice to disobey specific road rules and cross the road without regard for oncoming traffic. According to the Australian Road Rules, there are over sixteen separate rules that govern the way pedestrians are required to safely cross congested city streets (National Road Transport Commission, 2012). If any one of these rules is broken by a pedestrian, then that pedestrian is considered to be crossing the road in an illegal manner. When this occurs, pedestrians are referred to as jaywalkers. According to Jorgensen (2007), pedestrians who jaywalk can be divided into three main categories:

- Early walkers
- Late walkers
- Risk walkers

Early walkers are the individuals who enter cross walking just before the pedestrian signal turns green and finishes the crossing before the signal turns red. Although some people may be able to sometimes predict when the crossing signals will turn green, this prediction can be wrong and he or she may end up in a fatal accident. Late walkers are the ones who enter the crossing during a flashing red pedestrian light, which is the pedestrian clearance interval. Those walkers may be finishing the crossing when the pedestrian signal turns steady red, which is risky. Risk walkers are the pedestrians crossing the roads and streets while pedestrian the pedestrian signal is steady red. Previous studies have generally focused on evaluating the behaviours of pedestrians crossing the streets and identifying the factors which may have been the causes of such behaviours (Zhang et al., 2016).

There are several studies on jaywalking and pedestrian safety at midblock and intersection in the literature. A summary of some of the recent studies, especially at intersection, is presented in Table 1, which shows the aim of the studies, methodologies adopted and limitations of the study. The list in Table 1 is not exhaustive but provides an indication of the wide range of studies in this area (e.g. survey, field observation, simulation). Since the focus of the paper is on jaywalking behaviour at intersections, review of midblock jaywalking behaviour has been avoided. Detailed review of the literature has shown that there are two main factors that influence whether a pedestrian chooses to jaywalk or not: individual pedestrian characteristics and contextual characteristics. Both of these broad categories have multiple factors within that can potentially influence a pedestrians' jaywalking likelihood. Similar to most behavioural and contextual influences, these effects may vary depending on the populations and locations.

However, most of the studies on jaywalking behaviour are done overseas and little research has been done in the Australian context. Therefore, the aim of this study is to explore pedestrians' jaywalking behaviours using video observation at selected intersections in Melbourne, Victoria. This study is a part of a larger project that aims to develop and test on-site communications tools to reduce jaywalking at intersections. In this paper, we present only the preliminary results from the video data that have been collected from a sample of intersections, as detailed analyses are currently underway.

The structure of the paper is as follows. The next section presents the data collection, which is then followed by data analysis and key results. The final section presents the conclusions and recommendations for future research.

Table 1: Summary of recent studies on pedestrians walking behaviour

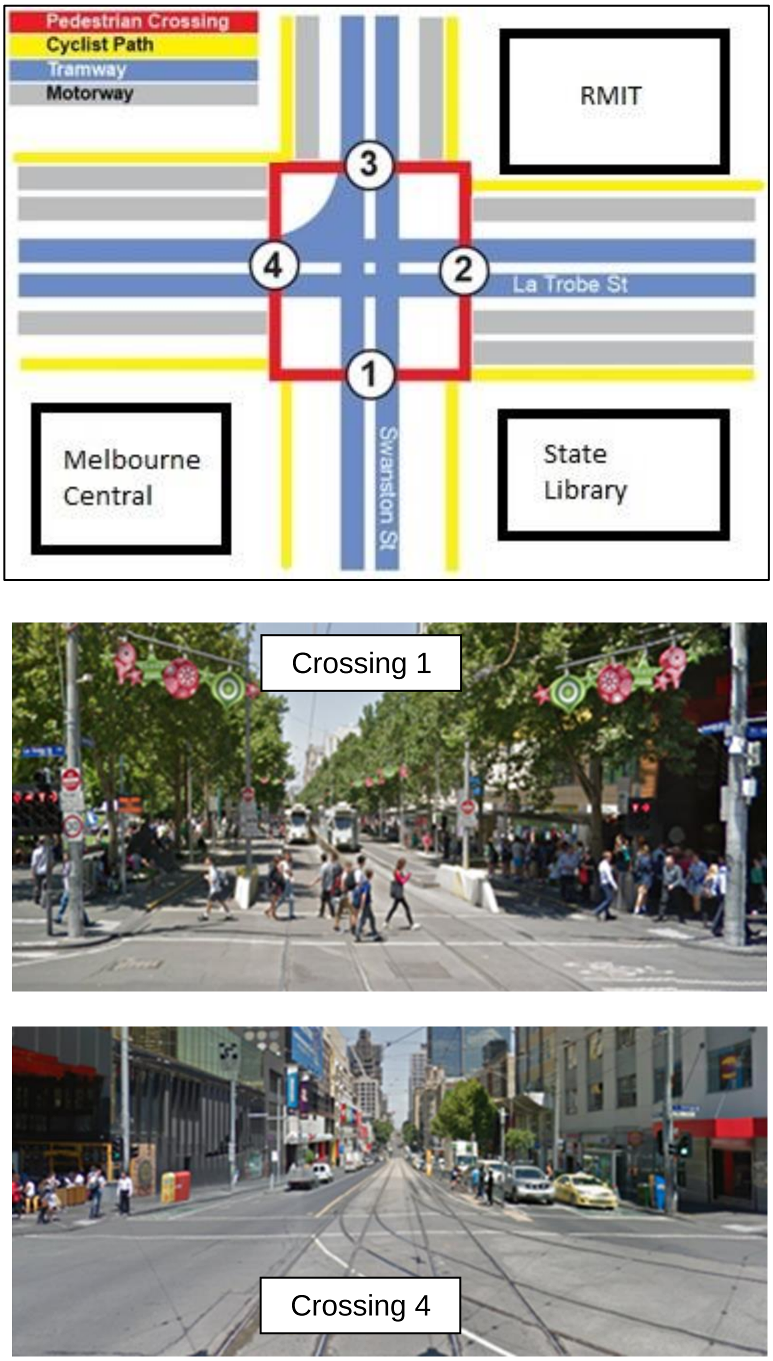
Reference	Aim of Study	Method	Limitations
(de Lavalette et al., 2009)	To examine the effects of countdown timers on the crossing behaviours of pedestrians in congested streets around France.	Observing pedestrians' behaviour when crossing an intersection with a countdown timer, and conducting a comparative analysis.	Amount of traffic, specific types of intersections and street-types were all ignored in this study.
(Hatfield & Murphy, 2007)	To analyse how the use of a smartphone can influence road crossing behaviours.	Observational studies to establish the walking characteristics of pedestrians using a mobile phone.	Results were standardized, failing to take into account individual characteristics.

Reference	Aim of Study	Method	Limitations
(Holland & Hill, 2010)	To establish which of the following socio-economic characteristics is most influential on jaywalking: Age, gender, driving experience or mobility.	Simulation study that shows a video of two-way traffic to pedestrians, and asking them to step forward, indicating when they would cross the road.	Other variables directly related to age were not taken into consideration (such as cognitive function).
(Kurilkin & Ivanov, 2016)	To determine if tracking algorithms are more accurate than manual calculations.	Counting the number of pedestrians, both manually, and using regression modelling.	The use of tracking algorithms is heavily reliant on clear video footage (face and body type must be easily identifiable).
(Lennon et al., 2017)	To identify the extent to which pedestrians cross the road, while using a smartphone.	Online study to gain insight into individual pedestrian characteristics.	Adolescents (the highest number of smartphone users), were not included in the survey.
(Lobjois & Cavallo, 2007)	To analyse how pedestrians' judge an appropriate and safe crossing time, based on oncoming vehicle speed.	Marking the full width of the road on the floor of a lab, and simulating single lane oncoming traffic. Then, getting participants to indicate when they would cross.	This study did not take into consideration pedestrians with mobility issues (screened them out during the simulation).
(Nakai & Usui, 2016)	To analyse the influence of senior pedestrians on road traffic accidents.	Using traffic data collected in Japan, to analyse the number of accidents that involved senior citizens and license holders only.	This study was purely data based, and did not involve self-reports, such as questionnaires.
(Rosenbloom, 2009)	To examine the effects of conformity on pedestrians at signalized road crossings.	A sample group of pedestrians were observed at a specific time of day, both individually and as a group.	Comparative analysis could not be made, as few studies focus solely on the effects of conformity.
(Tom & Granié, 2011)	To explore gender differences in pedestrian rule compliance.	Groups of pedestrians at two signalized and two un-signalized intersections were analysed and compared.	Observers collected data at only one intersection, and at the same time of the day.
(Williamson & Lennon, 2015)	To investigate if pedestrian self-reports matches their behaviours (particularly when using a smartphone).	Gathering a sample group of pedestrians, and using observational studies in conjunction with a questionnaire.	Questionnaires data reveal socially desirable bias.

2. Data collection and extraction

Video data of pedestrian crossings were collected at congested streets around the RMIT City Campus, located in Melbourne. The Swanston Street - La Trobe Street intersection (see Figure 1) was selected for this study because of the availability of a safe, elevated location to record pedestrian behaviours unobtrusively from a café on the second floor of Melbourne Central. Data were collected during day-time off-peak hours on the weekend to minimise the effects of congestion. Relevant ethics clearance for the video data collection was obtained from the RMIT University Human Research Ethics Committee.

Figure 1: Swanston Street - La Trobe Street intersection



The intersection is located at RMIT City Campus, Melbourne Central Station and State Library of Victoria. As there are many amenities, including universities, hospitals, shopping centres and restaurants, a diverse range of pedestrians, including teenagers, adults and the older population are seen crossing the intersections. There are four pedestrian crossings at this intersection. Crossing 1 has only a tram track, cyclist path and pedestrian walkway. Crossing 3 has a one lane road, a tram line and a cyclist path. Both crossings 2 and 4 have a two-lane road, a tram line and a cyclist path. The video data were recorded at crossings 1 and 4 due to the ability to video record from an elevated position. Also, crossing 4 is nearly double in distance compared with crossing 1 (approx. 24.2 m vs. 12.5 m), which provides us the opportunity to explore the effect of crossing distance on jaywalking. A total of 50 full pedestrian cycles were recorded at each crossing.

Relevant video data were manually processed to extract jaywalking behaviours. Jaywalking data were disaggregated into three categories:

1. Started crossing during flashing red signal
2. Started crossing during steady red signal
3. Herd jaywalking

The ‘herd jaywalking’ refers to the scenario where a pedestrian who first jaywalks influences other pedestrians to follow.

Contributing factors to jaywalking were classified into the following types:

1. Social interaction
2. Using mobile device
3. Speaking on mobile phone
4. Using headphone

Social interaction was considered as a contributing factor when a pedestrian was talking to his or her colleague(s) or partner(s) while crossing together. The category of using mobile device referred to a pedestrian who held a mobile device in hand while doing something with it while crossing. Speaking on mobile phone included any pedestrian who was speaking on the phone while crossing the road. Using headphone or earphone included any pedestrians crossing the roads with these devices visible on his or her ears.

3. Analyses and Results

A total of 6.24 ± 4.70 jaywalkers per pedestrian signal cycle at crossing 1 and 4.78 ± 3.10 jaywalkers at crossing 4 were observed. These represent a total of around 7% jaywalkers out of the total pedestrian population who crossed at crossing 1 and 20% jaywalkers out of the total pedestrian population who crossed at crossing 4 respectively. These observations show that the jaywalking behaviour quite is prevalent at this intersection.

The average number of jaywalkers per pedestrian signal cycle was further divided into jaywalkers during flashing red light, jaywalkers during steady red light and herd jaywalkers. As shown in Table 2, the number of jaywalkers during flashing red light was higher in crossing 4 than crossing 1. In contrast, the number of jaywalkers during steady red light was significantly higher (p-value <0.05) in crossing 1 as compared to crossing 4. Further, we observed a number of herding jaywalking behaviour at both crossings in the intersection. The higher number of jaywalking during flashing red along Crossing 4 may also indicate that the signal timing is not well designed for the pedestrian volume it is handling which will be examined in future.

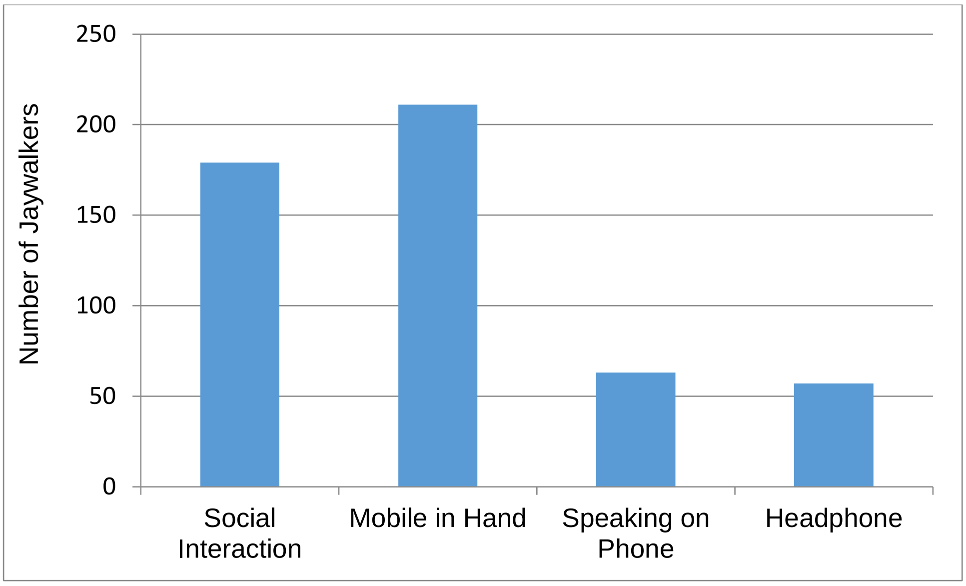
Table 2: Average number of jaywalkers per pedestrian signal cycle

Jaywalking behaviour	Average number of jaywalkers per pedestrian signal cycle (Mean ± Standard Deviation)	
	Crossing 1	Crossing 4
Jaywalking during flashing red	3.68 ± 2.82	4.36 ± 2.86
Jaywalking during steady red light	2.56 ± 3.30	0.42 ± 0.66
Herd jaywalking	0.62 ± 1.14	0.06 ± 0.31

In terms of gender, we did not find any significant differences between the mean number of male and female jaywalker per signal cycle, although the mean number of male jaywalkers per pedestrian signal cycle was slightly higher than female jaywalkers.

To identify some of the factors contributing to jaywalking behaviour, a more detailed data extraction was conducted for crossing 1. The numbers of jaywalkers exhibiting the various behaviours observed during the 50 pedestrian signal cycles are shown in Figure 2. Using mobile devices and social interactions were the two most frequently observed behaviours associated with jaywalkers.

Figure 2: Contributing factors observed at the crossing 1



The numbers of distracted walkers when the pedestrian signal was green, flashing red and steady red are reported in Table 3. The distracted jaywalkers represent around 16%, which is quite concerning since distraction can have an impact on the pedestrians' safety due to the lack of attention to the oncoming traffic, especially those who are doing jaywalking on red pedestrian signal. There are also a high number of pedestrians who are distracted during green light and may have an effect on other pedestrians' movement by slowing down or colliding with other pedestrians.

Table 3: Distracted pedestrians and crossing behaviours

Crossing behaviours	Number of distracted jaywalkers per pedestrian signal cycle (Mean ± Standard Deviation)	Percentage of total distracted pedestrians
Crossing during green light (non-jaywalkers)	9.1 ± 3.02	84.23
Crossing during flashing red light	1.0 ± 1.23	9.27
Crossing during steady red light	0.7 ±1.04	6.50

4. Discussion and Conclusion

Jaywalking at signalised intersections is risky and may lead to vehicle-pedestrian collisions, resulting in serious pedestrian injury or fatality. This research explores the frequency and potential contributing factors of jaywalking at one intersection in Melbourne using video data. We find that jaywalking and distracted behaviour is common at the intersection. Around 7% of the total number of pedestrians who crossed at crossing 1 jaywalk and about 20% of the total number of pedestrians who crossed at crossing 4 jaywalk. These statistics are concerning to road safety professionals because of the higher risks of vehicle-pedestrian collisions associated with jaywalking. Therefore, more effort should be invested in developing appropriate engineering, education and enforcement measures to reduce these risky behaviours.

There are several possible reasons for the higher total number of jaywalkers observed at crossing 1 compared crossing 4. First, crossing 1 is much shorter than crossing 4 (24.2 m vs. 12.5 m). Second, only trams and cyclists (but not cars, motorcycles or heavy vehicles) traverse crossing 1, whereas trams, cyclists and other vehicles traverse crossing 4. Third, the frequency of trams is much lower than vehicles like cars and motorbikes, which may provide more opportunities and times for pedestrian to cross the street at crossing 1. Fourth, acceleration and speed of trams is lower, which may prompt pedestrians to think that the risk of collision is lower.

We also found that there were substantial numbers of jaywalkers during flashing red light in both crossings. It may be that some of the pedestrians are not aware of rules on crossing the road during flashing red light, as there are many international students or visitors who use the crossing to go to the RMIT University. These students or visitors may not have a correct understanding of the road rule that requires pedestrians not to start crossing the road when the red light is flashing. Hence, appropriate pedestrian campaigns or messages should be developed to educate these students and change their risky behaviours.

Further, we also observe quite a number of herd jaywalking episodes, especially at crossing 1. Whenever pedestrians display herd jaywalking, it also increases the number of jaywalkers in that pedestrian signal cycle. In terms of gender, we did not find any significant differences in the number of jaywalkers per signal cycle between male and female. If the total numbers of male and female pedestrians are about the same, we can infer that there is no gender effect. This finding need to be further investigated in future studies.

Although the majority of pedestrians have shown cautionary behaviour during jaywalking by looking at both the right and left sides of the road before crossing, there are many pedestrians who are distracted and not looking at both ways before crossing. Using hand-held mobile devices (looking at the mobile phones, texting, picking up the call, etc.) are the most common types of distraction. Another noticeable type of distracted behaviour is social interaction with pedestrians talking to each other before and during the crossings. One example of the observed social interaction was two pedestrians talking to each other and not looking at traffic, and crossing during red light. The tram driver had to sound the horn several times before both pedestrians rush to the other side of the road. It could have led to serious pedestrian injury if the tram driver had not been attentive and sounded the alarm.

There are several limitations of the present study. We only explored one intersection at a relatively low speed environment (60 km/hr). More observations at different intersections in both low speed and high speed environments may help to understand different factors that influence pedestrians' jaywalking behaviour. This is currently underway at RMIT University. Further, there could be other factors that may influence jaywalking behaviour, including weather, presence of pedestrians warning signs, age and physical capability of the pedestrians, etc. which would be explored more detailed in future. Additionally, the observational studies fail to take into account the personality and cognitive function of the pedestrians. Each pedestrian has a different view regarding illegal road crossing behaviours that is partly based on what they have learnt from a young age, as well as their everyday experiences on the roads. Hence, there is need of more diverse data collection, such as a questionnaire survey, to determine the personal factors influencing jaywalking behaviour. Proper understanding of these factors is critical to developing any engineering, education or enforcement measure to reduce jaywalking behaviour at intersections.

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