

TeMA

Journal of
Land Use, Mobility and Environment

The three issues of the 12th volume will think again the debate on the definition and implementation of methods, tools and best practices connected to the evolution of the main scientific topics examined in depth in previous TeMA Journal volumes.

Tema is the Journal of Land use, Mobility and Environment and offers papers with a unified approach to planning and mobility. TeMA Journal has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).



THE TIMES THEY ARE A-CHANGIN'

TeMA

Journal of
Land Use, Mobility and Environment

THE TIMES THEY ARE A-CHANGIN'

3 (2019)

Published by

Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realized by CAB - Center for Libraries at "Federico II" University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence

Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.tema.unina.it
e-mail: redazione.tema@unina.it

The cover image is a photo of impacts on transport infrastructure of typhoon Hagibis in Japan (October, 2019)

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

The Italian *National Agency for the Evaluation of Universities and Research Institutes* (ANVUR) classified TeMA as scientific journal in the Area 08. TeMA has also received the *Sparc Europe Seal for Open Access Journals* released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe) and the *Directory of Open Access Journals* (DOAJ). TeMA is published under a Creative Commons Attribution 3.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

EDITOR IN-CHIEF

Rocco Papa, University of Naples Federico II, Italy

EDITORIAL ADVISORY BOARD

Mir Ali, University of Illinois, USA

Luca Bertolini, University of Amsterdam, Netherlands

Luuk Boelens, Ghent University, Belgium

Dino Borri, Polytechnic University of Bari, Italy

Enrique Calderon, Polytechnic University of Madrid, Spain

Roberto Camagni, Polytechnic University of Milan, Italy

Derrick De Kerckhove, University of Toronto, Canada

Mark Deakin, Edinburgh Napier University, Scotland

Aharon Kellerman, University of Haifa, Israel

Nicos Komninos, Aristotle University of Thessaloniki, Greece

David Matthew Levinson, University of Minnesota, USA

Paolo Malanima, Magna Græcia University of Catanzaro, Italy

Agostino Nuzzolo, Tor Vergata University of Rome, Italy

Rocco Papa, University of Naples Federico II, Italy

Serge Salat, Urban Morphology and Complex Systems Institute, France

Mattheos Santamouris, National Kapodistrian University of Athens, Greece

Ali Soltani, Shiraz University, Iran

ASSOCIATE EDITORS

Rosaria Battarra, National Research Council, Institute of Mediterranean studies, Italy

Gerardo Carpentieri, University of Naples Federico II, Italy

Luigi dell'Olio, University of Cantabria, Spain

Isidoro Fasolino, University of Salerno, Italy

Romano Fistola, University of Sannio, Italy

Carmela Gargiulo, University of Naples Federico II, Italy

Thomas Hartmann, Utrecht University, Netherlands

Markus Hesse, University of Luxembourg, Luxembourg

Seda Kundak, Technical University of Istanbul, Turkey

Rosa Anna La Rocca, University of Naples Federico II, Italy

Houshmand Ebrahimpour Masoumi, Technical University of Berlin, Germany

Giuseppe Mazzeo, National Research Council, Institute of Mediterranean studies, Italy

Nicola Morelli, Aalborg University, Denmark

Enrica Papa, University of Westminster, United Kingdom

Dorina Pojani, University of Queensland, Australia

Floriana Zucaro, University of Naples Federico II, Italy

EDITORIAL STAFF

Gennaro Angiello, Ph.D. at University of Naples Federico II, Italy

Stefano Franco, Ph.D. student at Luiss University Rome, Italy

Federica Gaglione, Ph.D. student at University of Naples Federico II, Italy

Carmen Guida, Ph.D. student at University of Naples Federico II, Italy

Rosa Morosini, Ph.D. student at University of Naples Federico II, Italy

Andrea Tulisi, Ph.D. at Second University of Naples, Italy

THE TIMES THEY ARE A-CHANGIN'

3 (2019)

Contents

223 EDITORIAL PREFACE
R. Papa

FOCUS

227 **Defining urban green infrastructure role in analysis of climate resiliency in cities based on landscape ecology theories**
E. Shirgir, R. Kheyroddin, M. Behzadfar

249 **Mega-Event Organization Considering Safety, Security and Resilience**
F. Atun Girgin, O. Edizel Tasci

LAND USE, MOBILITY AND ENVIRONMENT

265 **High speed rail and airport. Future scenarios in Marco Polo Airport in Venice**
P. Pucci, G. Lanza

283 **Walking and talking. The effect of smartphone use and group conversation on pedestrian speed**
L. R. Walsh, T. T. Xian, D. M. Levinson, H. S. Rayaprolu

295 **Elders' quality of life and urban accessibility. A method proposal for spatial planning**
F. Gaglione, C. Gargiulo, F. Zucaro

313 Land-Use and Transport integration policies and real estate values. The development of a GIS methodology and the application to Naples (Italy)
G. Carpentieri, C. Guida, P. Chorus

331 Air Transport Implications in Tourist Destinations. The Trapani Airport in Western Sicily
E. Calderon, P. Ventura, A. Massaro

351 REVIEW PAGES
G. Angiello, F. Gaglione, C. Guida, R. Morosini, A. Tulisi

TeMA

Journal of
Land Use, Mobility and Environment

TeMA 3 (2019) 283-294
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/6088

paper received 1st May 2019, accepted 12th September 2019
Licensed under the Creative Commons Attribution - 4.0 International License
www.tema.unina.it

How to cite item in APA format:

Reynolds Walsh, L., Xian, T., Levinson, D. & , Rayaprolu, H.S. (2019). Walking and talking. The effect of smartphone use and group conversation on pedestrian speed. *Tema. Journal of Land Use, Mobility and Environment*, 12 (3), 283-294. doi: <http://dx.doi.org/10.6092/1970-9870/6088>



WALKING AND TALKING

THE EFFECT OF SMARTPHONE USE AND GROUP CONVERSATION ON PEDESTRIAN SPEED

Lexie Reynolds Walsh^a, Tingsen (Tim) Xian, David Levinson
Hema Sharanya Rayaprolu

School of Civil Engineering, University of Sydney, Australia
e-mail: lexie.walsh@gmail.com; txia0093@uni.sydney.edu.au
david.levinson@sydney.edu.au; hema.rayaprolu@sydney.edu.au

^a ORCID: <https://orcid.org/0000-0001-6435-333X>

ABSTRACT

Distracted walking due to smartphone use is on the rise resulting in growing concern over pedestrian safety and well-being. Our study measured the walking speeds of pedestrian groups differentiated by their smartphone use in two different environments - a wide pedestrian bridge at a university, and a narrow footpath on a busy commercial street. The results show that groups of people, phone users, and often followers of phone users, walk significantly slower than solo walkers uninfluenced by phone. Especially on the narrow street, people in groups and phone users are seen to not only slow themselves down but also slow the people walking behind them.

KEYWORDS:

Walking; High-speed Rail; Catchment Area; Intermodal Complementarity; Scenario

TeMA

有关土地使用、交通和环境的杂志

TeMA 3 (2019) 283-294
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/6088

paper received 1st May 2019, accepted 12th September 2019
Licensed under the Creative Commons Attribution - 4.0 International License
www.tema.unina.it

How to cite item in APA format:

Reynolds Walsh, L., Xian, T., Levinson, D. & , Rayaprolu, H.S. (2019). Walking and talking. The effect of smartphone use and group conversation on pedestrian speed. *Tema. Journal of Land Use, Mobility and Environment*, 12 (3), 283-294. doi: <http://dx.doi.org/10.6092/1970-9870/6088>



行与说：智能手机使用和群聊对行人走路速度的影响

Lexie Reynolds Walsh^a, Tingsen (Tim) Xian, David Levinson
Hema Sharanya Rayaprolu

School of Civil Engineering, University of Sydney, Australia
e-mail: lexie.walsh@gmail.com; txia0093@uni.sydney.edu.au
david.levinson@sydney.edu.au; hema.rayaprolu@sydney.edu.au

^a ORCID: <https://orcid.org/0000-0001-6435-333X>

摘要

使用智能手机让越来越多的人在走路的时候分心，也让行人安全和福祉问题日益受到关注。我们的研究通过两个不同的环境：大学里的宽阔人行天桥，狭窄的繁忙商业街人行道。研究不同的智能手机使用方式对行人群体步行速度的影响。结果表明，人群、电话用户以及频繁关注电话用户的行走速度，明显慢于没有电话影响的独行者。尤其是在狭窄的街道上，人群中使用电话的用户不仅放慢了自己的脚步，也让其身后的人群步伐变慢。

关键词：

步行；高速铁路；集水区；多式联运的互补性；情境

1 INTRODUCTION

Growing environmental and health concerns have directed a multitude of research into walking, pedestrian behaviour and safety (Papa, 2008; Rahaman & Lourenco, 2010; Shbeeb & Awad, 2013; Soltani et al., 2018). Our study examines the impact of smartphone use on pedestrian movement. While walking is a multi-dimensional activity serving various purposes like mobility, leisure, exercise, social interaction, etc., this study focuses mainly on the transport aspect of walking, especially walking speed. Walking speed has been measured in a variety of contexts ranging from pace of life studies to human factors and behavioural to transportation studies (Chandra & Bharti, 2013, Clark-Carter et al., 1986; Finnis & Walton, 2008; Fitzpatrick et al., 2006; Franek, 2013; Levine & Norenzayan, 1999; Moussa et al., 2010; Tanaboriboon, 1986; Tarawneh, 2001; Walmsley & Lewis, 1989). But as smartphones have come to be almost ubiquitous across the world, the issue of smartphone use while walking arises. With increasing phone-related injuries and incidents among pedestrians (Nasar & Troyer, 2013; Smith et al., 2013), the behavior of distracted pedestrians has been widely investigated. The majority of the studies are however experimental (Mwakalongo et al., 2015) and report diverse findings. While (Haga et al., 2015; Nasar et al., 2008) and (Schwebel et al., 2012) find distracted pedestrians to exhibit unsafe behaviour, (Lopresti-Goodman et al., 2012) find them to act with more caution, and (Stavrinou et al., 2011) and (Timmis et al., 2017) find their behaviour to be unaffected by distractions. Nevertheless, when pedestrians were observed in their natural environments, those that were distracted with activities using phones were found to walk slower and display less caution (Nasar et al., 2008; Bungum et al., 2005; Hyman et al., 2010; Thompson et al., 2012). Bungum et al., (2005) assessed the relationship between distracted walking and routine cautionary behaviours of pedestrians crossing a street. Trained observers recorded the distractions (wearing headphones, talking on a mobile-phone, eating, drinking, smoking, or talking with another pedestrian) and cautionary behavior (looking left and right before crossing, entering the crosswalk only during the 'walk' phase) of 866 pedestrians. Using regression analysis, they found that distraction was negatively but weakly correlated with displaying caution.

In one of their studies, (Nasar et al., 2008) observed the behaviour of 127 pedestrians at three cross walks to estimate their safety. They found that mobile phone users crossed more unsafely than those using iPods or none of the devices. (Hyman et al., 2010) observed 317 pedestrians crossing a square at Western Washington University and investigated the effects of divided attention during walking. They observed that mobile phone-users walked slower, changed directions more frequently, and were less likely to acknowledge people and notice unusual activities in the surroundings in comparison to the others. They did not find any significant differences in behaviour across genders, in contrast to (Ortiz et al., 2017) who found females and the young to be more prone to distraction by phone use or talking to others in their observation of pedestrian and driver interactions. In another study, (Thompson, 2013) observed 1102 pedestrians at 20 high-risk intersections in Seattle, Washington to investigate the impact of technological and social distraction on pedestrian cautionary behaviours and crossing times.

They found mobile phone use and talking with a companion to increase crossing times. In an examination of the association between distracted behaviours and optimal crossing behaviour, they found text messaging while crossing to be associated with the highest risk. While many studies show smartphone use reduces the walking speed of the distracted pedestrian, the impact of the smartphone using pedestrians on the walking speed of those following them and the pedestrian traffic in general has been unexplored.

Our study addresses this gap. We investigate the impact of smartphone using pedestrians on others and the overall walking speed in different pedestrian environments in Sydney, Australia, by recording and examining video footage. Our hypothesis is that smartphone using pedestrians become obstacles for the non-smartphone users, who thus slow their walking speed.

The alternative hypothesis I that pedestrians not using smartphones adapt their behaviour to accommodate the smartphone users by perhaps weaving around them and increase their walking speed to overtake.

In this scenario, the use of smartphones would primarily affect the walking speeds of individual pedestrians using the devices but would not actually have any effect on the average speed of other travelers. In addition, the behaviour of pedestrians in groups is studied and posited to have similar effects.

2 METHODOLOGY

We examined pedestrian movements at two sites:

- on a university pedestrian bridge - City Road Bridge;
- on a busy commercial street - Bay Street.

At each of the sites, we recorded the pedestrian activity and measured walking speeds based on the collected footage. From the videos, we carefully logged the distance covered in the frame, and the time taken for each pedestrian to pass through the frame to extract their walking speed. Speed was calculated by dividing the distance walked by the time taken to walk. Each pedestrian was time stamped, and their direction of travel was noted. Other characteristics recorded include gender, whether they walked alone or in a group, and whether or not they were using their phone while walking.

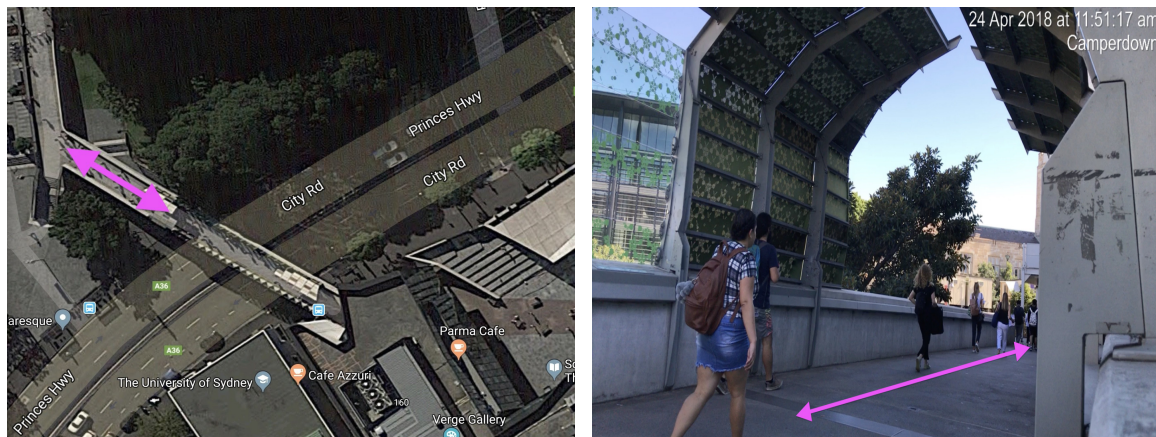


Fig. 1 Site 1: City Road Bridge. (a-left) Camera Layout (b-right) Measuring Zone: 24 m on the west (far) side of the Bridge, 18 m on the east (near)

The datasets for sites 1 and 2 have 180 and 477 reference items respectively, each one corresponding to a pedestrian, and include the relevant information on that pedestrian as outlined above. The data were broken down for analysis based on gender, walking in groups, and smartphone usage: the walking speeds of the pedestrians in various categories were then evaluated.

Further, to explore the impact that phone users had, the walking speeds of pedestrians following phone users with a headway less than 5 seconds were also evaluated. Finally, the results were tested for statistical using z-tests. Details of each of the sites are discussed in turn.

3 SITE 1: CITY ROAD BRIDGE

Site 1 (Fig. 1) consists of a pedestrian bridge over City Road on the University of Sydney campus. Video footage was recorded during a school day, April 24, 2018 between 11:24am and 12:34pm, just prior to lunchtime to ensure maximum pedestrian traffic. During the recording period, the conditions were clear, with light breeze and approximately 23°C. Pedestrian movements in the first ten minutes of the video were logged for speed measurement.

The logged data were then analyzed in conjunction with a more general observation of the rest of the footage. The general observation of the footage offered insights into trends that the logged data did not pick up. For example, the most obvious trend seen in the video observation is that pedestrians who were texting while walking were careful to keep to the left in their direction of travel (in Australia, pedestrians generally walk on the left). In this people walking in groups.

Based on this observation, further information was logged from the videos: the number of times that pedestrians overtook one another and whether the pedestrians overtaken were using smartphones or not.

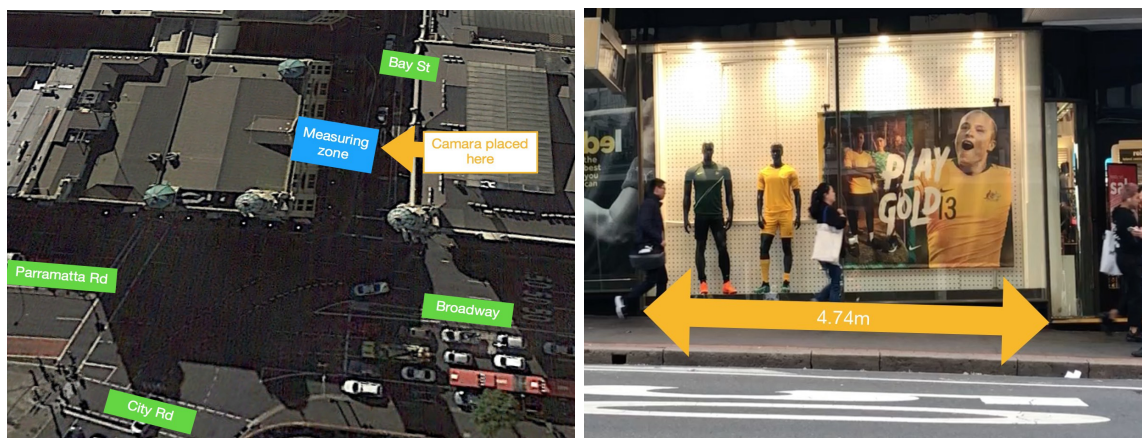


Fig. 2 Site 2: Bay Street. (a-left) Camera layout Bay St (b-right) Measuring zone Bay St

4 SITE 2: BAY STREET

Three videos were collected at Bay St, Ultimo, NSW, a busy street in a commercial district. They had been collected from 4:42 pm to 4:55pm on a Tuesday, 1 May, 2018, and from 11:11 am to 11:28am and from 4:22 pm to 4:38 pm on a Wednesday, 13 June, 2018.

The camera was located about halfway on the east sidewalk facing west between Grose St and Broadway (refer to Fig 2(a) and (c)). The camera was facing West and was placed on the other side of the road in order not to narrow the walkway under observation. The segment observed is shorter than in site 1 to avoid distractions in movements caused by shop entrances and exits. We expect this to aid the comparability of the results.

5 RESULTS AND DISCUSSION

5.1 CHARACTERISTICS OF PEDESTRIANS

The characteristics of pedestrians observed at sites 1 and 2 are shown in Tab. 1. Pedestrians at site 1 were mainly university students, which explains the similar share of female and male pedestrians. The greater number of female pedestrians at site 2 could be due to its location in a commercial shopping district, as shopping remains gendered (Roy Dholakia, 1999; Taylor et al., 2015).

Interestingly, an equal share of female and male students used their phones while walking, while male pedestrians on Bay Street were seen to use phones more than their female counterparts, an observation that contrasts the findings of studies where female pedestrians were observed to be equally or more likely to be distracted (Hyman et al., 2010; Ortiz et al., 2017; Smith et al., 2013).

Phone usage was nevertheless observed to be higher among students than pedestrians in the commercial district, as one would expect. Gender was significant in another dimension: women were more likely to walk in groups than men at both sites, and the likeliness was significant at site 1. Pedestrians following phone users with a headway less than 5 seconds were sporadic at both sites.

	SITE 1			SITE 2		
	Total	Male	Female	Total	Male	Female
Number of Pedestrians	180	92	88	477	207	270
Using phones	17%	17%	17%	12%	14%	11%
Not using phones	83%	83%	83%	88%	86%	89%
Phone user followers	7%	6%	1%	12%	5%	7%
Walking alone	72%	82%	61%	67%	71%	64%
Walking in a group	28%	18%	39%	33%	29%	36%

Tab. 1 Descriptive statistics

5.2 WALKING SPEED ANALYSIS

Walking speeds of pedestrians observed at both sites differentiated by gender, phone use, and walking companions are shown in Tab. 2. As one would expect, the average walking speed on the busy Bay Street (site 2) was higher than that on the wide, dedicated pedestrian bridge on campus (site 1).

As expected, pedestrians using phones had lower walking speeds than those not using phones and the general walking speeds, but the difference was not significant enough to fall outside the standard deviation of the general walking speed at both sites. The results for phone use followers do not align with our initial hypothesis that pedestrians using phones would slow down the other pedestrians around them.

Pedestrians using phones had no discernible effect on the walking speed of the pedestrians following them. While the walking speeds of phone user followers at site 2.

	SITE 1			SITE 2		
	All	Male	Female	All	Male	Female
All	1.21 (0.32)	1.24 (0.32)	1.17 (0.31)	1.31 (0.25)	1.34 (0.25)	1.29 (0.25)
Using phones	1.16 (0.30)	1.09 (0.33)	1.22 (0.24)	1.20 (0.20)	1.25 (0.24)	1.15 (0.16)
Not using phones	1.22 (0.32)	1.28 (0.31)	1.16 (0.33)	1.33 (0.25)	1.36 (0.25)	1.30 (0.26)
Phone user followers	1.34 (0.29)	1.33 (0.28)	1.38 (0.47)	1.25 (0.24)	1.30 (0.15)	1.22 (0.29)
Walking alone	1.31 (0.26)	1.32 (0.26)	1.28 (0.26)	1.36 (0.24)	1.40 (0.21)	1.32 (0.25)
Walking in a group	0.97 (0.32)	0.90 (0.34)	1.00 (0.31)	1.22 (0.26)	1.21 (0.29)	1.23 (0.24)

Tab. 2 Walking speed (m/s) of all pedestrians, phone-users, groups, and pedestrians following phone-users and groups (The values in brackets correspond to the standard deviation)

were comparable to the speeds of phone users, at site 1, pedestrians following phone users had speeds higher than the average. This is perhaps because phone using pedestrians were overtaken by the surrounding pedestrians who increased their walking speed temporarily during the overtaking, thereby producing no net effect on the general pedestrian speed.

To investigate this hypothesis, further analysis on overtaking patterns was undertaken at site 1 - discussed in the subsequent section.

The general walking speed of male pedestrians was slightly higher than that of the female pedestrians at both sites. This difference was fairly consistent across the categories except for male phone users at site 1, however the difference fell within the standard deviation.

The average walking speeds of male phone user followers at site 1, and male pedestrians walking in groups at both sites are almost negligibly lower than that of their female counterparts. Pedestrians walking in groups had lower walking speeds than those walking alone and the general population at both sites.

Although a clear slowing in the tempo of pedestrians walking in groups as compared to those walking alone was evident at site 1, the difference was not large enough to fall outside the standard deviation of the general walking speed. The difference was even smaller at site 2.

	MALE	FEMALE	OVERALL
People overtaken	13	20	33
Texting	2	3	5
Calling	0	0	0
Holding phone only	1	5	6
In a group	3	13	16
Alone with no phone	7	2	9
People that overtook others	13	9	22
Texting	0	1	1
Calling	0	0	0
Holding phone only	1	0	1
In a group	1	1	2
Alone	12	8	20
Not using phone	13	8	21

Tab. 3 Data on the Overtaken: Site 1

5.3 OVERTAKING PATTERNS AT SITE 1

Tab. 3 details characteristics of the overtaken and the overtaking pedestrians. For the analysis of overtaking patterns, we differentiated phone using pedestrians by what they appeared to be doing on their phones - texting, calling or just holding their phones while walking to identify patterns at a greater detail. Among all the observed pedestrians, only 33 (18%) were overtaken.

The data show that female pedestrians were more likely to be overtaken than male pedestrians. This is likely because most female pedestrians who were overtaken were walking in groups, and of the people who were overtaken, 48% were walking in groups. It may be that women are more likely to be overtaken simply because they are more likely to walk in groups, as seen in Tab.1, or there could be another unknown reason for this that has not been captured by this investigation. Male pedestrians were more likely to overtake than female pedestrians, perhaps because they tend to walk faster as seen in 1.

Overtaking pedestrians were likely to be walking alone (91%), and not using their phones (95%). A group of two people, one male and one female, was the only group to overtake in the footage. One male pedestrian held his phone as he overtook, and one female pedestrian managed to overtake while texting - in fact, she overtook two people. The analysis on overtaking patterns was undertaken with the expectation that most pedestrians who were using phones would be overtaken.

However, results show that the vast majority of people who were using phones were not overtaken.

The following additional points were noted during observation of the footage:

- texters kept to the left (Australia is a drive/walk on the left country) in their direction of travel - they tended to hug the wall as they passed over the bridge, and most looked up periodically;
- people in groups appeared to be less aware of their surroundings and took up more space than texters;
- no collisions or near misses were noted;
- pedestrians more easily overtook people using smartphones than people walking in groups;

- A slightly higher number of women (5%) than men carried their phones without using them: this could be explained by the fact that women's clothing has less functional pockets than men's clothing. If a female pedestrian was between texts, she may be less likely to put her phone away in her bag where she would be unlikely to hear or feel notifications, whereas a male pedestrian may be more likely to slip his phone back in his pocket while waiting for a reply. In addition, some women may keep their phone in their hand while listening to music for a similar reason. Without examining all the female pedestrians' pockets or asking them why they were holding their phones without using them, it is hard to make a definitive statement on this.

Overall, the results from the data collected on the City Road Bridge indicate that smartphone usage among pedestrians has little effect on overall pedestrian speed. However, this seems counter-intuitive given that people using smartphones have been shown to walk more slowly than without a smartphone, and walk with a reduced ability to follow a set pathway correctly (Bugum et al., 2005; Haga et al., 2015; Hyman et al., 2010; Lopresti-Goodman, 2012; Nasar et al., 2008; Thompson et al., 2010). Increases in injury rates have also been documented (Nasar & Troyer, 2013; Smith et al., 2013). It is thought that the effect of smartphone use would be more significant in areas with heavier pedestrian traffic, at different times of day, and perhaps with a slightly different demographic.

Most of the pedestrians seen in the video footage were almost certainly university students, around 18-35 years. At around 11:30 am, these students would not yet be late for a 12pm class, and so would not likely be rushing. Further, just before 12pm is about the time friends may meet for lunch, and therefore be more likely to be walking in groups than using their phones. Another location and time of day may yield different results. At 8am in Sydney CBD for example, a high volume of pedestrians aged 18 years and up would more likely to be walking alone on their way to work.

It is possible that under this scenario, smartphone use is more prolific and the effect on general pedestrian speed would be more significant and obvious. Further, a higher number of people walking past one another may mean that smartphone usage among some pedestrians does slow the walking speeds of other people. The barricades on the sides of the pedestrian bridge may also be affecting pedestrian behaviour. It is noted that most texters kept to the left and stayed very close to the barricade as they walked.

However, if the edge of the footpath met a busy road this may not be the case: people using smartphones may be more likely to walk close to the centre of the footpath where they would be more difficult to overtake.

6 SIGNIFICANCE OF RESULTS

To test the observed results for validity, we performed a series of Z-tests and found that the Z-test generally corroborate the observations, as shown in Tab.4.

The differences in walking speeds between most groups are significant beyond an 80% level. This is also true for the comparisons between sites. The results can hence be validated to be significant.

7 CONCLUSION

Observation of walking behaviour reveals or confirms the following: Males walk faster than females, females are more likely to walk in groups, females are more likely to carry articles in their hands than males. The results of the investigation from site 1, a wide university bridge, show that pedestrians using smartphones did not have a significant impact on overall pedestrian speed on the pedestrian bridge. Average walking speeds of pedestrians walking near smartphone users were not significantly different from the average speed. Overtaking pattern analysis showed that most people using smartphones were not overtaken either. It was found that people walking in groups were most likely to be overtaken by other pedestrians. In contrast, site

REFERENCES

- Bouterse L. & Wall-Scheffler C. (2018). Children are not like other loads: a cross-cultural perspective on the influence of burdens and companionship on human walking. *PeerJ*. 6:e5547. doi: <https://doi.org/10.7717/peerj.5547>
- Bungum T.J., Day C., & Henry L.J. (2005). The association of distraction and caution displayed by pedestrians at a lighted crosswalk. *Journal of Community Health*. 30(4):269–279. doi: <https://doi.org/10.1007/s10900-005-3705-4>
- Chandra S. & Bharti A.K. (2010). Speed distribution curves for pedestrians during walking and crossing. *Procedia-Social and Behavioral Sciences*. 104:660–667. doi: <https://doi.org/10.1016/j.sbspro.2013.11.160>
- Clark-Carter D., Heyes A., & Howarth C. (1986). The efficiency and walking speed of visually impaired people. *Ergonomics*. 29(6):779–789. doi: <https://doi.org/10.1080/00140138608968314>
- Finnis K.K. & Walton D. (2008). Field observations to determine the influence of population size, location and individual factors on pedestrian walking speeds. *Ergonomics*. 51(6):827–842. doi: <https://doi.org/10.1080/00140130701812147>
- Fitzpatrick K., Brewer M., & Turner S. (2006). Another look at pedestrian walking speed. *Transportation Research Record: Journal of the Transportation Research Board*. (1982):21–29. doi: <https://doi.org/10.1177/0361198106198200104>
- Franěk M. (2013). Environmental Factors. Influencing Pedestrian Walking Speed. Perceptual and Motor Skills. 116(3):992–1019. doi: <https://doi.org/10.2466/06.50.PMS.116.3.992-1019>
- Haga S., Sano A., Sekine Y., Sato H., Yamaguchi S., & Masuda K. (2015). Effects of using a smart phone on pedestrians' attention and walking. *Procedia Manufacturing*. 3:2574–2580. doi: <https://doi.org/10.1016/j.promfg.2015.07.564>
- Helbing D., Molnár P., Farkas I.J., & Bolay K. (2001). Self-organizing pedestrian movement. *Environment and Planning B: Planning and Design*. 28(3):361–383. doi: <https://doi.org/10.1068/b2697>
- Hyman Jr I.E., Boss S.M., Wise B.M., McKenzie K.E., & Caggiano J.M. (2010). Did you see the unicycling clown? Inattentive blindness while walking and talking on a cell phone. *Applied Cognitive Psychology*. 24(5):597–607. doi: <https://doi.org/10.1002/acp.1638>
- Levine R.V. & Norenzayan A. (1999). The Pace of Life in 31 Countries. *Journal of Cross-Cultural Psychology*. 30(2):178–205. doi: <https://doi.org/10.1177/0022022199030002003>
- Lopresti-Goodman S.M., Rivera A., & Dressel C. (2012). Practicing safe text: the impact of texting on walking behavior. *Applied Cognitive Psychology*. 26(4):644–648. doi: <https://doi.org/10.1002/acp.2846>
- Moussaïd M., Perozo N., Garnier S., Helbing D., & Theraulaz G. (2010). The walking behaviour of pedestrian social groups and its impact on crowd dynamics. *PloS one*. 5(4). doi: <https://doi.org/10.1371/journal.pone.0010047>
- Mwakalonge J., Siuhi S., & White J. (2015). Distracted walking: Examining the extent to pedestrian safety problems. *Journal of Traffic and Transportation Engineering (English Edition)*. 2(5):327–337. doi: <https://doi.org/10.1016/j.jtte.2015.08.004>
- Nasar J., Hecht P., & Wener R. (2008). Mobile telephones, distracted attention, and pedestrian safety. *Accident Analysis and Prevention*. 40(1):69–75. doi: <https://doi.org/10.1016/j.aap.2007.04.005>
- Nasar J.L. & Troyer D. (2013). Pedestrian injuries due to mobile phone use in public places. *Accident Analysis and Prevention*. 57:91–95. doi: <https://doi.org/10.1016/j.aap.2013.03.021>
- Ortiz N.C., Ramnarayan M., & Mizenko K. (2017). Distraction and road user behavior: an observational pilot study across intersections in Washington, DC. *Journal of Transport & Health*. 7:13–22. doi: <https://doi.org/10.1016/j.jth.2017.05.362>
- Papa E. (2008). Subway & Skyway System: Sustainable Infrastructure for Walking? *TeMA. Journal of Land Use, Mobility and Environment*. 1(3). doi: <https://doi.org/10.6092/1970-9870/186>
- Rahaman K.R., & Lourenço J. (2010). Pedestrian Planning in City Centers: a Study of Guimarães and Braga. *TeMA Journal of Land Use, Mobility and Environment*. doi: <https://doi.org/10.6092/1970-9870/134>
- Roy Dholakia R. (1999). Going shopping: key determinants of shopping behaviors and motivations. *International Journal of Retail & Distribution Management*. 27(4):154–165. doi: <https://doi.org/10.1108/09590559910268499>

Stavrinos D., Byington K.W., & Schwebel D.C. (2011). Distracted walking: Cell phones increase injury risk for college pedestrians. *Journal of Safety Research*. 42(2):101–107. doi: <https://doi.org/10.1016/j.jsr.2011.01.004>

Schwebel D.C., Stavrinos D., Byington K.W., Davis T., O'Neal E.E., & De Jong D. (2012). Distraction and pedestrian safety: How talking on the phone, texting, and listening to music impact crossing the street. *Accident Analysis and Prevention*. 45:266–271. doi: <https://doi.org/10.1016/j.aap.2011.07.011>

Shbeeb L., & Awad W. (2013). Walkability of School Surroundings and its Impact on Pedestrian Behaviour. *Tema Journal of Land Use, Mobility and Environment*. pp.171–188. doi: <https://doi.org/10.6092/1970-9870/1608>

Smith D.C., Schreiber K.M., Saltos A., Lichenstein S.B., & Lichenstein R. (2013). Ambulatory cell phone injuries in the United States: an emerging national concern. *Journal of Safety Research*. 47, 19–23. doi: <https://doi.org/10.1016/j.jsr.2013.08.003>

Soltani A., Pour M.H., Sholeh M., & Zare P. (2018). The Development of a Walkability Audit. Based on Iranian Cities Pedestrian Environment. *TeMA. Journal of Land Use, Mobility and Environment*. 95–108. doi: <https://doi.org/10.6092/1970-9870/5468>

Tanaboriboon Y., Hwa S.S., & Chor CH. (1986). Pedestrian characteristics study in Singapore. *Journal of transportation engineering*. 112(3), 229–235. doi: [https://doi.org/10.1061/\(ASCE\)0733-947X\(1986\)112:3\(229\)](https://doi.org/10.1061/(ASCE)0733-947X(1986)112:3(229))

Taylor B.D., Ralph K., & Smart M. (2015). What explains the gender gap in schlepping? Testing various explanations for gender differences in household-serving travel. *Social Science Quarterly*. 96(5), 1493–1510. doi: <https://doi.org/10.1111/ssqu.12203>

Tarawneh M.S. (2001). Evaluation of pedestrian speed in Jordan with investigation of some contributing factors. *Journal of Safety Research*. 32(2), 229–236. doi: [https://doi.org/10.1016/S0022-4375\(01\)00046-9](https://doi.org/10.1016/S0022-4375(01)00046-9)

Thompson L.L., Rivara F.P., Ayyagari R.C., & Ebel B.E. (2013) Impact of social and technological distraction on pedestrian crossing behaviour: An observational study. *Injury Prevention*. 19(4), 232–237. doi: <https://doi.org/10.1136/injuryprev-2012-040601>

Timmis, M. A., Bijl, H., Turner, K., Basevitch, I., Taylor, M. J., & van Paridon, K. N. (2017). The impact of mobile phone use on where we look and how we walk when negotiating floor based obstacles. *PLoS one*, 12(6). doi: <https://doi.org/10.1371/journal.pone.0179802>

Walmsley D.J. & Lewis G.J.(1989) The Pace of Pedestrian Flows in Cities. *Environment and Behavior*. 21(2):123–150. doi: <https://doi.org/10.1177/0013916589212001>

AUTHOR'S PROFILE

Lexie Reynolds-Walsh has a Bachelor of Arts (Social Anthropology and History) and a Bachelor of Engineering (Civil) both completed at the University of Sydney. She is currently a Project Engineer with Roads and Maritime Services NSW working in Regional Maintenance Division at Wagga Wagga.

Tingsen (Tim) Xian is a current Transport Engineering student at the University of Sydney. He started research in Pedestrian Behaviour in 2017. He is a founding member of the Institute of Transportation Engineers the University of Sydney chapter.

David Levinson joined the School of Civil Engineering at the University of Sydney in 2017 as Foundation Professor in Transport Engineering. He was a Professor at the Department of Civil, Environmental, and Geo- Engineering at the University of Minnesota, from 1999 to 2016. He conducts research on Accessibility, Transport Economics, Transport Network Evolution, and Transport and Land Use Interaction. He is the Founding Editor of *Transport Findings* and the *Journal of Transport and Land Use*. He is the author of several books including: *The Transportation Experience*, *Planning for Place and Plexus*, *A Political Economy of Access*, *Elements of Access*, and *The End of Traffic and the Future of Access*. He blogs at <http://transportist.org>.

Hema Rayaprolu is currently a PhD candidate at the University of Sydney. She has a Master of Science degree in Transportation Systems from the Technical University of Munich. Her research interests include Transport Network Evolution, Travel Demand Modelling, Transport and Land Use Interaction, and Planning for Walking and Cycling.