Abstract
Since the launch of the smartphone game “Pokemon Go”, the worldwide craze has led to numerous traffic crashes and injuries resulting from falling or tripping. This paper investigates the effects of several smartphone distracting activities (gaming, talking, texting, Web surfing, and listening to music) on the street-crossing behaviours of pedestrians in Taipei City, Taiwan. A field study using video cameras was conducted to observe pedestrian crossing behaviours (e.g., crossing time, sudden movements, running a red light, and walking outside the crosswalk) at a selected signalised intersection. Data such as phone features, distracting activities, and personal attributes of the pedestrians were obtained in interviews conducted after pedestrians had completed crossing the street. In total, 1995 pedestrians engaging in various smartphone activities were observed. Results indicate that unsafe crossing behaviours were more prevalent among those playing “Pokemon Go”. Texting via instant-message apps appeared to be the second-most risk distracting activity. Results of the logistic models reveal that contributing factors to unsafe behaviours include being a student, phone screen of 5 in. or larger, and having an unrestricted 4G Internet data allowance. Two interaction terms (gaming x students, and gaming x unlimited 4G data allowance) in the models appear to be important determinants of unsafe crossing behaviours. The current research suggests that to prevent potential crashes and injuries, smartphone gaming while crossing the street should be prohibited.

Keywords: Crossing behaviour; Red-light violation; Smartphone; Gaming; Pedestrian safety

1. Introduction

Evidence in literature has suggested that a secondary task such as calling and texting while walking causes increased cognitive distraction and reduced situation awareness (Hatfield and Murphy, 2007; Nasar et al., 2008). Texting and walking at the same time was reported to pose a greater deal of threat to public safety by ignoring their surroundings (or ambling across the street) (Neider et al. 2010; Thompson et al., 2013; Sotiraki et al, 2012; Schwebel et al., 2012).

Recent handsets/smartphones with touch screens and more-advanced features, including multimedia and mobile applications (apps) provide diverse data, information, and convenience to users. There has been a rapid phone-use shift from calling or texting to Web surfing, texting/calling via an app, and gaming (Jeong et al., 2016). Increased attention has been recently directed at the adverse effect of smartphones on road safety. In a laboratory study, Byington and Schwebal (2013) reported that browsing the Internet on a smartphone while crossing a virtual street resulted in longer waiting time, missing more safe opportunities to cross, taking longer to initiate crossing when a safe gap was available, looking left and right less often, spending more time looking away from the road, and greater risks in being hit or almost hit by an oncoming vehicle.

Smartphone gaming can be a particular hazard to all road users because it involves multiple types of distraction: manual, visual, and cognitive. The smartphone game "Pokemon Go" launched by Nintendo is fuelling public safety fears over vehicle crashes, and it is not uncommon for pedestrians distracted by "Pokemon Go" to commit dangerous trespassing or street crossings. Compared to a less cognitive-demanding, less interactive, and non-augmented-reality game, Pokemon Go poses the potential for distraction from tasks requiring greater concentration. Pokemon Go players have to move (by cycling or walking) and use their phone cameras to capture free-roaming Pokemon characters. By walking farther, players can catch more Pokemon characters and hatch their Pokemon eggs. Training one's own Pokemon characters and battling other enemy characters require extensive tapping on the phone screen for attacking and swipe left/right for dodging. Since the launch of the smartphone game, the worldwide craze has led to numerous traffic crashes and injuries resulting from falling or tripping. Trespassers searching for Pokemon characters with their phones may be considered home invaders, putting their lives in dangers as owners may attempt to defend their property and life.

There are relatively few studies that have investigated the effects of phone gaming on road safety. Past studies on texting messaging and Web surfing may be relevant to smartphone gaming, as both require smartphone users to fix their eyes on their handsets to text, surf, and play. A review study by Caird et al. (2014) has reported that texting while driving is a dual task that often reduces one's ability to control one's vehicle, with such manifestations as reduced manoeuvrability, increased speed variability, and improper lane changes. A Virginia Tech Transportation Institute study investigating the impacts of distracted driving in commercial motor vehicle operations reported that texting while driving increases the crash risk of a driver by 23-fold (Neider et al. 2010).

Results from studies investigating texting and walking indicate that texting creates a significantly greater interference effect on walking than does listening to music or talking on a mobile phone. Compared to pedestrians who were using their phones for other purposes (e.g., talking or listening to music), pedestrian texters were less able to maintain their walking speed, and were more likely to pose a threat to public safety by ignoring their surroundings (or ambling across the street) (Neider et al. 2010). A laboratory study by Byington and Schwebal (2013) examined whether browsing the Internet on a smartphone while crossing a virtual street compromised the safety of young adult pedestrians. The study reported that pedestrians distracted by Web surfing were found to wait longer to cross the street, missed more safe opportunities to cross, took longer to initiate crossing when a safe gap was available, looked left and right less often, spent more time looking away from the road, and were more likely to be hit or almost hit by an oncoming vehicle.

Effects of excessive smartphone gaming on certain anatomic injuries have been established in medical science. For instance, Gilman et al. (2015) reported that excessive use of and addition to smartphone gaming were associated with tendon rupture. In a laboratory experiment in which 24 undergraduate students texted a message, watched a video, and played a game, Haga et al. (2015) examined the subjects' responses when simultaneously performing visual and auditory detection tasks. They found that compared to other types of phone uses, such as texting a message and watching a video, users of smartphone games had the worst gait performance (i.e., ability to walk and balance) and had the highest number of missed visual targets. A laboratory experiment was conducted by Hyong (2015) to examine the effects of several distracting events (listening to music, texting a message, Web surfing, and gaming) on dynamic balance. Hyong concluded that playing smartphone games most significantly decreased one's cognitive ability, causing the greatest decrease in dynamic balance, which was followed by texting a message, Web surfing, and listening to music. In a field experiment study where 24 cyclists' cycling behaviours were observed, smartphone gaming was found by De Waard et al. (2014) to increase swerving on a public cycle path the most (i.e., exhibiting greater variation in a cyclists' lateral position).

When reviewed together, literature has suggested that the effects of smartphone gaming has been less researched, even though it has rapidly increased in popularity, particularly among young people (Kim et al., 2015). The rapid development of smartphone features and technologies has increased the complexity of multitasking, thereby undermining pedestrian safety. Such smartphone developments include larger screen sizes, which may distract users to a greater degree; and fourth-generation (4G) mobile communication technology, which offers quicker data transmission. To the authors' knowledge, few studies have identified the effects of smartphone gaming, along with smartphone features and technologies, on pedestrians' unsafe street-crossing behaviours.

1.1. Purpose

The current research attempts to examine street-crossing behaviours of pedestrians distracted by a smartphone. The main purpose of this study was to investigate the effects of smartphone gaming on street-crossing behaviours, compared to other distracting activities such as talking, texting, Web surfing, and listening to music.

2. Methods

2.1 Participants and Procedures

Pedestrians' street-crossing behaviours were observed in a real-life environment. Video cameras were set up to observe pedestrians' road-crossing behaviours at a selected location. All pedestrians that were observed to be distracted by their phones were participants in the study. Distracting activities include talking on a phone, texting, gaming, surfing the Web, and listening to music. After a road crossing that involved a distraction was completed, the pedestrian was interviewed to confirm his/her distracting activity, and other variables such as demographic information, handset features, etc. To identify smartphone users, only those using a smartphone with a touchscreen were included in the study as keypad smartphones were found to be very rare. Feature phones were found to be rarely used and were thus excluded from the analysis. Those jogging and listening to music were excluded.

Video cameras were used to capture pedestrians' street-crossing behaviours such as crossing time, sudden movements, running a red light, and walking outside the crosswalk. Pedestrians who arrived at the intersection on a green-light phase were not considered – only pedestrians facing a red light phase were included in the study. Once a subject had completed crossing the street, he/she was stopped by a research assistant and interviewed to obtain additional variables that were not available in the video clip. The additional variables include demographic information (age, gender, and occupation) and handset characteristics (Internet allowance tariff, and phone size). A small gift (i.e., a pen and a handy notebook worth approximately US$1) as an incentive was provided to those willing to be interviewed. All aspects of the study were approved by the Taipei Medical University Institutional Review Board.

The app game “Pokemon Go” was launched in Taiwan on 6 August 2016, and the observational field study was conducted from 6 August to 5 September 2016 on weekdays and weekends during three periods of the day: morning peak hours (07:00~09:00), off-peak time (12:00~14:00), and afternoon off-peak hours (1600-1800). With regard to the location, the observation study was carried out at a signalised two-lane street, with a width of 18 m (see Figure 1). Participants would first have to intersect with turning vehicles (from the left-hand side) and subsequently vehicles from the right-hand side that had completed a U-turn manoeuvre. The speed limit for the street was 20km/h, and the timing of the pedestrian-light cycles was 90 s (65 s for the red light and 25 s for the green light).

2.3. Variables considered

Several smartphone distraction activities were considered: calling (traditional call and call via an app), texting a message (traditional texting and texting via an instant-messaging app), listening to music, surfing the Web (using Facebook, Instagram, etc.), and gaming (any type of smartphone gaming). The category "traditional texting" was removed because no such case was observed. As for the variable "gaming", a vast majority of those gaming with their smartphones were playing "Pokemon Go" – of the 2021 valid cases, only 26 pedestrians were playing other games such as Candy Crush. To avoid confounding the data, these 26 pedestrians playing other smartphone games were removed from the analysis.

The outcome measures (i.e., street-crossing behaviours) include crossing time, sudden movements, running a red light, and walking outside the crosswalk. Definitions of the outcome variables are as follows. Sudden movements were defined as those who suddenly stopped/accelerated at any point while crossing the street. Those who crossed the street during a red phase (i.e., a do-not-cross signal) were considered to be running a red light. Those not walking within the crosswalk were classified as "walking outside the crosswalk".

The independent variables considered include the age, gender, student status, smartphone screen size, monthly Internet data allowance, and social context. These variables are described in greater details below. Pedestrian attributes include demographic information, namely age, gender, and student status. Age (in years) was the only continuous variable measured. Students are the variable of interest in the present study as they are hypothesised to be more likely to be addicted to smartphone use (Lepp et al., 2016), and to certain phone games such as "Pokemon Go". Only one temporal factor was examined, namely "time of observation": rush hour (07:00~09:00 or 17:00~19:00), or non-rush hour (09:01~16:59).

There seems to be no prior research that has examined the effect of smartphone screen size. The “screen size” is a categorical variable that comprises two levels: smaller than 5 inches and 5 inches or above. Research has (Reeves et al., 1999) suggested that users tended to spend more time on viewing a larger screen display. We therefore hypothesise that larger screen sizes would be more cognitively distracting and demanding than smaller ones.

The current research assumes that pedestrians’ street-crossing behaviours might vary according to the Internet data allowance; for instance, eye fixation duration is probably longer (and thus a greater likelihood of walking more slowly) for people with an unlimited Internet data allowance. The variable “mobile Internet” has three levels: unlimited use (use as much as you want), restricted use (restricted data allowance), and none (no Internet subscription). In the current research, social conformity variables such as the numbers of pedestrians crossing illegally were measured on both sides of the street. The numbers of pedestrians crossing illegally were measured when the subject (pedestrian) arrived at the location and was waiting.

2.4. Analysis

All data collected were entered into an Excel spreadsheet, and SPSS (vers. 22; IBM) was used for the data analysis. Distributions of various distracting activities by the independent variables were first reported. The outcome variables (i.e., street-crossing behaviours such as the average crossing times, sudden movements, running a red light, and walking outside the crosswalk) were compared to one another by distracting activities. The average crossing times were compared using a t-test. Unsafe crossing behaviours of participants were compared to each other using χ^2 post hoc tests. Next, we examined the determinants of unsafe crossing behaviours such as sudden movements (including sudden stop and acceleration), running a red light, and walking outside the crosswalk. All multivariate analyses were conducted using a linear regression (with crossing time in seconds as the continuous outcome) and logistic regression (for unsafe crossing behaviours with binary outcomes; for instance, sudden movements vs. otherwise).

3. Results

3.1 General results

During the observation periods, participants observed to be using their phones and walking at the same time at the selected intersection were subjects of the study. In total, 1995 valid participants were included in the study. Two hidden cameras on both sides of the intersection were used to capture pedestrians' street-crossing behaviours. Subjects were naïve as to the purpose of the study, and their basic personal characteristics and phone attributes were obtained in a face-to-face interview by an experimenter after the crossing had been completed. Table 1 shows the distribution of various distracting activities by independent variables.

3.2 Crossing time

Next, we investigated and analysed pedestrian crossing times and the other three unsafe crossing behaviours among distracting activities (Table 2). Table 2 presents the proportion of unsafe crossing behaviours by pedestrians in each distraction group. For instance, in the "sudden movement" category, 5.7% texting messages (using an app) means that 5.7% of the pedestrians who were texters using an instant-messaging app had sudden movements within the crosswalk. It appears here that as many as 23.4% of those playing smartphone game (i.e., Pokemon Go) had sudden movements while crossing the street, which was the highest among all other pedestrians observed.

Regarding crossing times, smartphone gaming caused pedestrians to spend more time crossing (13.8ss), which is followed by those texters using an app (11.6 s). Differences are statistically significant compared with to “listening to music” category.

Pedestrians playing smartphone games exhibited the highest rate of running a red light (19.4%; $p<0.01$). Again, those gaming with smartphones were the most likely to walk outside the crosswalk (33.7%), and the difference was statistically significant compared to the “listening to music” group ($p<0.01$). Pedestrians who were text messaging using an app were the second most disobedient when facing a red light (8.9%; $p<0.05$), and the second most likely to walk outside the crosswalk (13.4%; $p<0.05$).

Table 3 reports the linear regression model of average crossing times. As reported in Table 3, those gaming with a smartphone (β=0.87, confidence interval (CI)=0.70~1.03), or texting messages via an app (β=0.63, CI=0.53~0.99) took significantly longer to cross the street than those listening to music. Student pedestrians took longer to cross the street (β=0.37, CI=0.12~0.52). Finally, pedestrians using phones with screens 5 inches or larger, and unlimited Internet data allowance crossed more slowly than did those using phones with screens smaller than 5 inches, and no Internet data, respectively.

3.3 Crossing behaviours

Several binary logit models of unsafe crossing behaviours were estimated. As reported in Table 4, smartphone gaming appear to result in pedestrians committing the most unsafe crossing behaviours: sudden movements (odds ratio [OR]=2.82, CI=1.90~3.76), running a red light (OR=2.98, CI=2.56~3.71), and walking outside the crosswalk (OR=2.55, CI=2.17~3.11). Those texting messages via an app appear to be the second most likely to commit such unsafe crossing behaviours (ORs=1.77 for sudden movements, 2.16 for running a red light, and 1.62 for walking outside the crosswalk).

Compared to other pedestrians, student pedestrians were found to be more likely to commit all three types of unsafe crossing behaviours. Here the interaction term "student x smartphone gaming" was added to the model estimation, and it was found that student users of smartphone gaming exhibited an increased likelihood of sudden movements by 112%, running a red light by 98%, and walking outside the crosswalk by 168%.

Female pedestrians were found to be more likely than males to perform all unsafe crossing behaviours, although the differences were only marginally significant. Nonrush hours appear to be associated with unsafe crossing behaviours (ORs=1.46 for sudden movements, 1.77 for running a red light, and 1.26 for walking outside the crosswalk).

Users of smartphones with screens 5 inches or larger exhibited an increased likelihood of engaging in the three unsafe crossing behaviours (ORs=1.71 for sudden movements, 2.11 for running a red light, and 1.53 for walking outside the crosswalk). An unlimited Internet data allowance was associated with the three unsafe crossing behaviours: pedestrians with unlimited Internet access were 2.94 times more likely to suddenly stop/accelerate, 1.64 times more likely to run a red light, and 1.79 times more likely to not walk in the crosswalk than were pedestrians with no mobile Internet access. Here one interaction effect "unlimited data allowance x smartphone gaming" was examined in the model, and it was found that those gaming with their smartphones and whose Internet data allowance was unlimited were respectively 2.15/2.65/2.34 times more likely to have sudden movements, run ared light, and walk outside the crosswalk.

There was an 16% increased likelihood of running a red light with an increase in the number of pedestrians illegally crossing from the same side. This result is consistent with previous studies (Nasar et al. 2008), which suggested that the decision to disobey a signal is influenced by social forces that favour herd behaviour. Pedestrians are likely to adopt herd behaviour when crossing a street; that is, they are more likely to cross if other pedestrians are doing so. This is possibly because pedestrians might feel safer making a dangerous crossing when doing so with others. Further studies can investigate whether the herd behaviour is particularly prevalent among people walking while using mobile phones, particularly smartphone gaming.

4. Discussion

Studies of the association between pedestrian behaviours and phone use have reported that mobile phone use was associated with slower crossing times and less-cautious behaviours (see, for instance, Byington and Schwebel, 2013). Our experimental study contributes to the literature by concluding that those engaging in distracting activities such as smartphone gaming (e.g., Pokemon Go) were the most likely to execute unsafe behaviours (e.g., sudden movements, running a red light, and walking outside the crosswalk). Those texting messages via an app appeared to be the second most likely to commit an unsafe crossing.

An expected finding is that, consistent with Thompson et al. (2013), individuals listening to music crossed more quickly than did those engaging in other distractng activities. Distractions other than music likely caused slower crossing times, because the visual attention of pedestrians had shifted from route planning to the distracting task. In the current research, smartphone gaming increased crossing times the most, and caused pedestrians to make more sudden movements within the crosswalk. Although these two crossing behaviours are not associated with an immediate crash risk with crossing vehicles, such behaviours may delay other pedestrians, thereby increasing their time to finish a crossing. In the event that a pedestrian spends a longer time (or has sudden movement) when crossing and is therefore unable to finish crossing in time, a conflict could arise from the pedestrian himself/herself (and the pedestrians behind) with crossing vehicles that are ready to initiate a crossing. In the event that a pedestrian stops or accelerates suddenly, a motorists is unlikely to react immediately and a crash could occur.

In the present paper, of all distracting activities, smartphone gaming appears to be the most important contributory factor to pedestrian's behaviour of running a red light. While running a red light can be associated with the immediate crash risk to pedestrians themselves, it could result in a crossing vehicle (that suddenly brakes to avoid colliding with a violating pedestrian) being struck by an oncoming vehicle behind. Those gaming with their smartphones, especially those playing Pokemon Go, should always bear in mind that they are exposing themselves to high risks of crashes when playing the game and crossing the street at the same time.

We specifically investigated the determinants of unsafe crossing behaviours. The results suggest that those with unlimited mobile Internet data allowance tended to commit unsafe crossing behavioiurs. Past laboratory studies (Byington and Schwebel,

2013) have reported that Web surfing would lead pedestrians to commit risky crossings. Our study adds to the findings of Byington and Schwebel (2013) by reporting that unlimited Internet access and those gaming with their smartphones, tended to commit unsafe crossing behavioiurs such as sudden movements, running a red light, and walking outside the crosswalk. Phone screens 5 inches or larger were found to be associated with the three unsafe crossing behaviours. Perhaps those who play smartphone games need their screen sizes to be larger, and require more data allowance. Possible interventions may include educating the public about dangerous crossing behaviours that may arise from mobile phone use in general, and when using phones with large screens in particular. Our result relating to large screen sizes may guide phone manufacturers in their decision-making process; although handsets with large screens may be more eye-catching, the adverse effects of a large screen while crossing the street should not be overlooked.

Student pedestrians were found to be more likely to commit all three types of unsafe crossing behaviours. Student pedestrians gaming with their smartphones were found to be more likely to have sudden movements, run a red light, and walk outside the crosswalk. While students were found in literature (e.g., Lepp et al, 2016) to be more addicted to smartphone use, they are also more likely to be more addicted to smartphone gaming, implying that educational efforts should first be targeted towards student users of Pokemon Go.

The rapid increase in the popularity of smartphone gaming suggests that the risk of distraction and a subsequent accident or injury will increase. Besides education, counter-measures may include engineering and environmental modifications, as well as enforcement efforts. Environmental modifications separating pedestrians from motor traffic and promoting conflict-free crossings may be effective in areas with numerous jaywalking pedestrians. The enforcement of laws against dangerous walking/crossing while smartphone gaming, including texting while walking as implemented in Fort Lee, New Jersey, should also be considered in Taiwan to reduce the risk of distractions and accidents.

Similar to previous observational research, the current study has strengths as well as limitations. We observed numerous pedestrians distracted by phone use in a real-life environment and controlled for several influential variables, including the mobile screen size and 4G Internet data allowance, that have not been investigated in past studies to our knowledge. The current research also controlled for several terms interacting with smartphone gaming. Results show that two interaction variables, students x smartphone gaming, and unlimited Internet data allowance x smartphone gaming, were associated with the three unsafe crossing behaviours.

The present paper analysed the effects of several distracting activities on pedestrians' unsafe crossing behaviours, but it was not our attempt to link these distracting activities/behaviours to accident/injury risks. Our study is limited in the aspect that the experimental study was conducted on a street (where the speed limit was 20 km/h, and controlled by automatic signals) connecting a university campus and hospital, and in daylight conditions. Therefore, the results might not be representative of other locales and times. Our results should be interpreted with cautions – the current research was conducted in the month when the game was launched. The one-month observational study may not be representative, but can illustrate the potential risk of user injury if an augmented reality game like Pokemon Go becomes popular in the future.

5. Conclusions

With the rapid development of smartphone technology, investigating how smartphone gaming and the use of other phone features affect unsafe crossing behaviours is crucial. The present study demonstrated that smartphone gaming (i.e., Pokemon Go) in a real-world environment increased crossing times and increased the likelihood of unsafe crossing behaviours such as sudden movements, running a red light, and walking outside the crosswalk. The current research also contributes to the growing body of literature on technological distractions and pedestrian crossing behaviours by demonstrating that a large phone screen size (5 inches or above) and unlimited 4G Internet access impaired the safety of pedestrians who were gaming while walking. Our results relating to a large screen size may provide phone manufacturers with guidance on their decision-making process; undoubtedly large screens can be more eye-catching, but the divided attention caused by such large screens while walking should not be overlooked.

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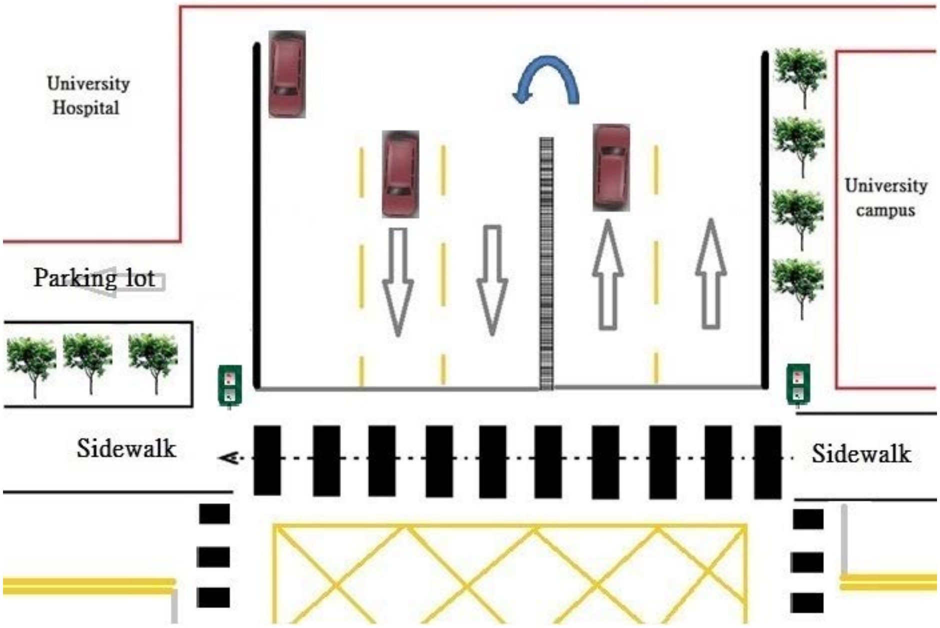

Figure 1: Designated intersection where pedestrians were observed

Table 1: Distribution of various distraction types by independent variables (n=1995)

Characteristics		Distracting activity						
		Listening to music (%)	Talking (traditional) (%)	Talking (using an app) (%)	Texting (using an app) (%)	Web surfing (%)	Gaming (%)	Total (%)
Gender	Male	74(51.8)	96(47.3)	147(47.6)	189(45.9)	54(57.4)	438(52.5)	998(50.1)
	Female	69(48.3)	107(52.7)	162(52.4)	223(54.1)	40(42.6)	396(47.5)	997(49.9)
Occupations	Students	121(84.6)	127(62.6)	218(70.6)	257(62.4)	70(74.2)	527(63.2)	1320(66.2)
	Others	22(15.4)	76(37.4)	91(29.4)	155(37.6)	24(25.5)	307(36.8)	675(33.8)
Age [b]		m: 20.3; s: 7.9	m: 29.8; s: 13.6	m: 21.2; s: 6.7	m: 24.2; s: 6.4	m: 20.2; s: 5.6	m: 23.6; s: 9.0	m: 24.2; s: 7.2
Screen size	< 5 inches	41(28.7)	106(52.2)	139(45.0)	174(42.2)	43(45.7)	371(44.5)	874(43.8)
	>=5 inches	102(71.3)	97(47.8)	170(55.0)	238(57.8)	51(54.3)	463(55.5)	1121(56.2)
4G Internet data allowance	Unlimited use	76(53.1)	110(54.2)	179(57.9)	267(64.8)	47(50.0)	644(77.2)	1323(66.3)
	Restricted use	31(21.7)	52(25.6)	83(26.9)	104(25.2)	28(29.8)	182(21.8)	480(24.1)
	None	36(25.2)	41(20.2)	47(15.2)	41(10.0)	19(20.2)	8(1.0)	192(9.6)
Number of pedestrians crossing illegally [a,b]	Same dir.	m: 0.6; s: 0.3	m: 0.7; s: 0.2	m: 0.8; s: 0.4	m: 1.2; s: 0.8	m: 0.6; s: 0.3	m: 1.7; s: 0.8	m: 0.9; s: 0.4
	Opposite dir.	m: 1.4; s: 1.1	m: 1.2; s: 1.5	m: 0.7; s: 0.2	m: 1.1; s: 0.9	m: 1.2; s: 0.4	m: 1.3; s: 0.6	m: 1.1; s: 0.6
	Both dir.	m: 2.3; s: 1.4	m: 2.0; s: 1.2	m: 1.5; s: 1.1	m: 2.1; s: 1.4	m: 1.7; s: 1.1	m: 3.1; s: 1.4	m: 2.1; s: 1.1
Total (%)		143(7.2)	203(10.2)	309(15.5)	412(20.7)	94(4.7)	834(41.8)	1995

[a] At the moment when the pedestrian arrived and was waiting

[b] The figures represent the mean (m) and standard deviation (s)

Table 2: Unsafe crossing behaviours by different distracting activities (n=1995)

	Averaged crossing time (s)	Sudden movements (%)	Running a red light (%)	Walking outside the crosswalk (%)
Listening to music	8.6	0.2	6.6	3.1
Talking (traditional)	8.9	0.5	7.8	2.9
Talking using an app	9.7*	0.3	8.1**	4.2**
Text messaging using an app	11.6**	5.7*	8.9*	13.4*
Web surfing	9.9*	2.7**	8.2*	9.3*
Gaming	13.8*	23.4**	19.4**	33.7**

* $p<0.05$ compared to the reference group "listening to music"

** $p<0.01$ compared to the reference group "listening to music"

Table 3: Impacts of distracting events and human or phone attributes on time to cross (in s) (n=1995)

	β	S.E.	95% CI	P-value
Distracting events				
Listening to music	Ref.			
Talking (traditional)	0.19	0.07	0.08 to 0.32	<0.01
Talking (using an app)	0.26	0.05	0.13 to 0.52	<0.01
Texting messages (using an app)	0.63	0.20	0.53 to 0.99	<0.01
Web surfing	0.55	0.15	0.30 to 0.94	<0.01
Gaming	0.87	0.29	0.70 to 1.03	<0.01
Student (ref. otherwise)	0.37	0.08	0.12 to 0.52	<0.01
Female	0.17	0.10	-0.09 to 0.36	0.23
Screen size of 5 inches or larger (ref. otherwise)	0.45	0.21	0.31 to 0.83	<0.01
4G Internet allowance				
Unlimited use	0.94	0.33	0.75 to 1.19	<0.01
Restricted allowance	0.37	0.16	0.21 to 0.67	0.03
None	Ref.			

Table 4: Odds of the three unsafe crossing behaviours by distracting activities and human or phone attributes (n=1995)

	Sudden movements		Running a red light		Walking outside the crosswalk	
Distraction type	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Listening to music	Ref		Ref		Ref	
Talking (using an app)	1.11(0.91, 1.33)	0.13	1.28(0.86, 1.53)	0.21	1.32(0.78, 1.69)	0.23
Talking (traditional)	1.43(1.23, 1.87)	0.03	1.32(1.06, 1.65)	<0.01	1.24(0.81, 1.56)	0.19
Texting messages (using an app)	1.87(1.53, 2.34)	<0.01	2.03(1.89, 2.47)	<0.01	1.62(1.30, 1.96)	<0.01
Web surfing	1.73 (1.42, 2.15)	<0.01	1.76 (1.51, 2.37)	<0.01	1.49 (1.27, 1.85)	<0.01
Gaming	2.98(1.50, 5.95)	<0.01	2.27(1.36, 3.80)	<0.01	2.55(2.17, 3.11)	<0.01
Students (ref. otherwise)	1.60(1.05, 2.43)	0.03	2.31(1.09, 4.89)	<0.01	1.72(1.20, 2.28)	<0.01
Students x Gaming (ref. otherwise)	2.21(1.73, 2.97)	<0.01	1.98(1.50, 2.79)	<0.01	2.68(2.27, 3.10)	<0.01
Female (ref. male)	1.30(0.93, 1.82)	0.13	1.33(0.89, 2.00)	0.16	0.76(0.57, 1.11)	0.25
Nonrush hours	1.46(1.17, 1.85)	<0.01	1.77(1.47, 2.18)	<0.01	1.26(0.91, 1.52)	0.18
Screen size of 5 inches or larger (ref. otherwise)	1.71(1.23, 2.39)	<0.01	2.11(1.34, 3.35)	<0.01	1.53(1.29, 1.96)	<0.01
4G Internet data allowance						
Unlimited use	2.94(2.67, 3.49)	<0.01	1.64(1.32, 2.02)	<0.01	1.79(1.44, 2.29)	<0.01
Restricted allowance	1.73(1.59, 2.16)	<0.01	1.21(1.03, 1.69)	0.03	1.23(0.88, 1.55)	0.13
None	Ref		Ref		Ref	
Unlimited data x gaming (ref. otherwise)	2.15(1.67, 2.53)	<0.01	2.65(2.29, 2.96)	<0.01	2.34(1.98, 2.86)	<0.01
Number of pedestrians crossing illegally from the participant side	-	-	1.16	<0.01	-	-
ρ^2	0.36		0.29		0.33	