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The light is red: uncertainty behaviours displayed by pedestrians during illegal road crossing

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ABSTRACT

Road accidents involving pedestrians are a reality of urban life. Pedestrian risk is now well known and documented from the perspective of drivers. However, pedestrian behaviour plays a central role in road accidents, notably in terms of illegal road crossing at signalized intersections. This study focuses on pedestrians crossing illegally at a signal light, and specifically investigates *uncertainty behaviour*, also referred to as *hesitation*, which occurs when a pedestrian slows down or stops his/her crossing movement then (1) abandons the crossing by returning to the kerb or (2) accelerates to cross the road more quickly. We sought to understand the causes of this behaviour in France and Japan, two countries where interesting differences have already been demonstrated in the way pedestrians behave. The results show a longer period of uncertainty for pedestrians in Japan compared to France. Japanese pedestrians also hesitated longer when they were alone. This study demonstrates a tendency to speed up if there are a number of pedestrians already crossing the road, but abandoning behaviours were more frequently observed than acceleration. This study confirms that pedestrians may misevaluate the moment to cross and hesitate when they realise that they have made a mistake, thus increasing the risk of an accident. These results could help to find solutions that prevent illegal and dangerous road-crossing behaviours.

KEYWORDS: illegal road-crossing; pedestrian; uncertainty; hesitation; decision-making; culture

INTRODUCTION

In 1896, Bridget Driscoll was killed by a motor vehicle during a demonstration in the United Kingdom; her death is the first recorded case of pedestrian road fatality (Porter, 1998). The number of road traffic accidents has since continued to rise, with pedestrians representing 22% of world road traffic death (World Health Organization, 2015, WHO/NMH/NVI/15.6). Despite the efforts made by governments to enhance road safety practices, there are still too many accidents involving pedestrians, most of which occur in urban agglomerations. In France, collisions with pedestrians represent 14% of lethal road accidents, and 67% of these deaths occur in the urban environment (ONISR, French Observatory of Road Safety, 2017). These deaths are all the more inacceptable given their largely predictable and preventable nature. Indeed, risks to pedestrians are now well known and documented in terms of driver behaviour (for speeding, see the review by Rosén et al., 2011; for drink driving see Hingson and Winter, 2003) to road infrastructures (see Bunn et al., 2003; Hamed, 2001) and vehicle design (see Desapriya et al., 2010).

Another key factor of pedestrian safety is the behaviour of the pedestrians. Zhuang and Wu (2011) showed that 66% of pedestrians crossing outside signalized intersections in China did not check for oncoming vehicles before crossing, and 16.1% did not even do so whilst crossing. Among pedestrians who saw an approaching vehicle after stepping off the kerb, 40.6% stopped crossing, 11.4% stepped backwards and 31.9% accelerated to complete the crossing. In this example, more than 40% of pedestrians demonstrated uncertainty behaviours. The authors observed many instances where pedestrians were using cell phones or listening to music while walking or even while crossing roads. The risky pedestrian behaviour described in this case is also problematic in the context of illegal road-crossings at signalized intersections (Diaz, 2002; Preusser et al., 2002; Evans and Norman, 1998; Evans and Norman, 2003; Rosenbloom, 2009; King et al., 2009; Xu et al., 2013).

Pedestrian behaviours vary according to the socio-demographic traits of individuals. Men show more risky behaviours than women, who display more compliance and conformity (Osman, 1982; Granié, 2011). These behaviours can also vary according to countries and social conventions (Sueur et al., 2013). For instance, French pedestrians crossed against the red light much more often than their Japanese counterparts (41.9% vs 2.1%) (Pelé et al., 2017). As unsafe behaviours, pedestrian infractions can be classified as either errors or violations (Reason, 1990). While an error is unintentional and associated with individual information, violation is deliberate and associated with social factors (Reason, 1990). Social information (gained from surrounding people) is an important factor in collective human phenomena and followership (Faria et al., 2010; Boos et al., 2014). For instance, Dyer and colleagues (2009) showed that a small percentage of informed individuals (5%) was sufficient to guide a larger group of uninformed people to a target place. At a signalised intersection, some pedestrians do not check the light colour but simply follow when other pedestrians have already started to cross (Pelé et al., 2019). Trusting wrong or unreliable information and following someone who is crossing without first checking the light colour (personal information) leads to an increased risk of accidents and injuries (Rosenbloom, 2009). Indeed, a conflict between these two types of information (social vs personal) may lead the pedestrian to change his/her behaviour while already crossing. Our study focuses on this specific behavioural change in pedestrians crossing illegally at a signal light. We have called this *uncertainty behaviour* (also referred to as *hesitation*). We define this specific behaviour as the moment the pedestrian slows down or stops his/her crossing movement then either (1) abandons the crossing by turning back to the kerb or (2) accelerates to cross more quickly. Both of these reactions are potentially dangerous for the pedestrian, who may be hit by vehicles driving on inner or outer road lanes.

To our knowledge, this is the first study to investigate the factors (sociodemographic and environmental) affecting uncertainty behaviour. This specific behaviour is a clear signal that the pedestrian has misevaluated the situation, and it deserves in-depth analysis. We also sought to identify any factors that could affect the abandon and acceleration rates observed in pedestrians. This was achieved by studying the behaviours of pedestrians crossing streets in two different countries: Japan and France. We have already demonstrated interesting differences in the way pedestrians behave in these two countries (Sueur et al., 2013; Pelé et al., 2017). First, there was a higher frequency of infractions in France than in Japan. In view of this finding, we predict a greater relative number of uncertainty behaviours in French pedestrians. Women and the elderly are expected to show more uncertainty behaviours and the longest uncertainty times in comparison to other categories of pedestrians when crossing at the red light. Indeed, women appear to focus more on the behaviour of other pedestrians at the time of crossing (i.e. prioritizing social information) (Tom and Granié, 2011) while older pedestrians (> 65 years old) appear to prioritize their course of travel over other environmental information (Tapiro et al., 2016a). Men and the youngest pedestrians are expected to accelerate after hesitation. At a pedestrian crossing red light, combining the number of pedestrians already crossing with the pedestrian departure order (rank) should increase the rate of illegal crossings and subsequently the rate of uncertainty behaviours, as pedestrians show mimetic process and trust in social information (Faria et al., 2010; Bode et al., 2015). We also expect any pedestrians who are using their phones or accompanied by another person to show more uncertainty behaviours than other pedestrians, as these factors are known as distractors (Neider et al., 2010; Tapiro et al., 2016b; Tapiro et al., 2018). Moreover, the probability of abandoning instead of accelerating should increase with the number of lanes on the road, as the risk and the perception of risk increase with the crossing distance.

MATERIALS & METHODS

Study sites

Pedestrians were observed at three sites in Strasbourg, France and at four sites in Nagoya, Japan (see details in Table 1). On each site, the speed of vehicles was limited to 50km/h. The speed of pedestrians when crossing the road was estimated by scoring the speed of 20 random pedestrians at each site. It was not significantly different from one site to another (permutation test for independent samples: maxT=2.22, p=0.168). At some sites, vehicles approaching the intersections were allowed to enter the road despite the green light for pedestrians; these drivers were aware that crossing pedestrians had priority and drove much more slowly than vehicles that were heading straight on. However, the driver of an approaching vehicle may be less careful if pedestrians cross at a red light, as the former has the right of way. Pedestrians therefore run a much higher risk of being injured when crossing at a red light. There was no button for pedestrians to trigger the green light at any of the sites.

Data scores

Data were scored over a six-day period for each site, for one hour per day during working days and between 12:00 and 17:00 to ensure that data included different groups of pedestrians (workers, families with children, retirees, etc.) but also excluded movements generated by social events (tourism, festivals, concerts, etc.). Observation time then varied within locations to get a wider pool of pedestrians. This scoring duration is sufficient to provide a large dataset (Faria et al., 2010; Sueur et al., 2013; Yannis et al., 2013). A video camera was set up in order to score the light colour in locations that were chosen to ensure that crossing pedestrians were visible at all times. We used the behavioural sampling method (Altmann, 1974) to score the behaviours of pedestrians in one direction only, i.e. those recorded by the camera. Pedestrians were not informed about the purpose of the study to avoid any modification of their behaviour. As both cities are touristic, pedestrians are accustomed to seeing tourists taking pictures or videos. Our camera was placed on the other side of the road to the starting point of pedestrians. It was not placed directly in front of the crosswalk but was located slightly to one side to make it less of a distraction for pedestrians before and during crossing. None of the pedestrians who noticed the camera changed their direction. To avoid influencing pedestrian behaviour, we purposely did not take any other equipment such as counters or pocket PCs. Any observations of road-crossing that were hampered by a visual obstacle (i.e. a car or a truck in front of the video camera) and the observations occurring immediately before and after it were removed from the analyses. We also removed data in which cyclists and tourists were among the pedestrians. We differentiated tourists from citizens without difficulty, as they were mostly in large groups accompanied by a guide, or carried specific equipment (camera or travel guide) and could be dressed differently to local citizens.

Research ethics

This study only involves anonymous observations and anonymous data scores. We followed the ethical guidelines for research of both countries and received ethical approval from both the Institut Pluridisciplinaire Hubert Curien, Strasbourg, France and the Primate Research Institute, Kyoto University, Japan to conduct our observations. As all data were anonymous, focal individuals were given sequential numerical identities according to the day of observation, the crossing concerned and the time of the road crossing. To avoid influencing pedestrians, the experimenters did not approach them. However, pedestrians had the opportunity to learn about the study by an informative medium in their language (French or Japanese) if requested after seeing the camera. If they wished to do so, they also had the possibility to obtain an email address and phone number to contact the corresponding author at a later date. Neither of the two Japanese pedestrians nor the three French ones who asked for information refused to participate in the study.

Data analyses

Uncertainty behaviours were analysed from video recordings by two teams of two coders (AR with AD and MJ with KB, each team coding for French and Japanese videos), using BORIS software (Friard and Gamba, 2016) and demonstrating all coder reliability of 80%. We only scored and analysed uncertainty behaviours observed at the red light on pedestrian crossings. However, in order to have a rate of uncertainty behaviour per illegal road-crossings, we also scored the number of illegal road-crossings behaviours in France and in Japan, regardless of the occurrence of uncertainty behaviour.

We defined the start of a crossing as the moment the pedestrian lifted one of his/her feet to cross. The *uncertainty behaviour* was defined as the moment the pedestrian stopped his/her crossing movement, or slowed down. This hesitation was then followed by one of two possible behaviours, i.e. scenario 1, the abandon of the road crossing, which is characterized by returning to the kerb, or scenario 2, acceleration, characterized by an acceleration of the crossing movement (Figure 1). These two possible behaviours following hesitation will hereafter be referred to as “subsequent behaviours”. We never observed a pedestrian who continued to cross at the same speed after hesitating, with speed estimated according to the number of steps per second.

Using these behavioural sequences, we defined *uncertainty time* as the time comprised between the beginning of the uncertainty behaviour and the beginning of the following behaviour (abandon or acceleration).

To determine the environmental and sociodemographic factors affecting uncertainty behaviour and its possible consecutive behaviours, we scored the following variables for each focal pedestrian:

- gender (male or female),
- age, estimated at 10-year intervals from 0–9, 10–19 [. . .] to 70–89.
- country (France or Japan),
- the number of lanes to be crossed,
- whether or not the focal pedestrian was using their phone,
- whether or not the pedestrian was accompanied (i.e. the pedestrian was talking with another person or walking very closely and synchronously with her/him, arriving at the road and crossing it at the same time),
- the total number of pedestrians involved in the road-crossing event,
- the departure order of pedestrians, where the first pedestrian to leave is ranked as 1, the second as 2, and so on. No uncertainty behaviour was noted after the sixth rank.

Statistical analyses

We first used chi-square tests to assess differences between countries and between genders. To evaluate the effect of age on uncertainty, we calculated the percentage of uncertainty behaviours (i.e. pedestrians as one behaviour per pedestrian) in each age category.

Two samples were used for this purpose: (1) a random sample of 1,278 pedestrians (N=551 for France and N=727 for Japan, with 2x10 minutes scorings for each site on two different videos) and (2) our sample of 118 pedestrians crossing at the red light and showing uncertainty in each country (N=80 for France and N=38 for Japan, see details for each site in Table 1). For each sample, we divided the number of individuals per age category by the total number of uncertainty behaviours (*100). We then calculated the differences between the two percentages in each age category: negative values indicated that fewer individuals showed uncertainty behaviours than the average for a given age category, while positive values indicated that more individuals showed uncertainty behaviours than the average. A Kolmogorov-Smirnov test was realised to compare the distributions of the hesitation frequency according to departure order. For this test, the mean departure order rank ± standard deviation per uncertainty behaviours is given per country.

A generalized linear model (GLM) was used to test the influence of the independent variables on our response variables. We first analysed the uncertainty time using a Gamma law (link = log) with the following independent variables: the age and the gender of the hesitating pedestrian, whether s/he was using a phone, whether s/he was accompanied by at least one other person, the country, the number of lanes, the number of waiting pedestrians, the order of pedestrian departure, the [country*gender] interaction and the [country*accompanied] interaction. Another possible biological and viable interaction would have been [country*age], but this was not tested due to insufficient data per age category. We then analysed the probability of abandon or acceleration using a Binomial law (abandon noted as 1, acceleration noted as 0) and with the following dependent variables: the age and the gender of the hesitating pedestrian, whether s/he was using a phone, whether s/he was accompanied by at least one other person, the country, the number of lanes, the number of waiting pedestrians and the order of pedestrian departure. For each GLM, we ran multi-model inferences to rank candidate models according to (i) their respective Akaike information criterion after correction for small sample sizes (AICc) and (ii) normalized Akaike weights (AICw) (Burnham and Anderson, 2004). ΔAICc is the difference in AICc between a given model and the model with the lowest AICc. AICw indicates the probability that a given model will be the best among candidate models (Burnham and Anderson, 2004; Burnham et al., 2011; Johnson and Omland, 2004).

All models were considered, from the null model (0 variable) to the full models (all tested variables). Models were ranked and compared according to their AICc, with the lowest AICc indicating the best model. Models with a difference of AICc (ΔAICc) <4 were considered equally possible candidates and their statistics (estimate, z-score and p-value) were averaged according to Bartoń's method (2013). The null model was also included as a possible candidate but was never among the models with lowest AICc. Averaged model coefficients were obtained for models with a ΔAICc < 4. Model inference and averaging were carried out with the R package 'MuMIn' (Bartoń, 2013).

A Pearson correlation test was used to assess whether the relative number of abandons and accelerations increased or decreased significantly according to the pedestrian's departure order (this analysis was carried out until the sixth rank, as no pedestrians were observed hesitating after this rank order).

Statistical analyses were performed using Rstudio 1.0.143 (Team RStudio, 2015) and the significance level was set at 0.05.

RESULTS

a) Factors affecting uncertainty behaviour

We observed 80 uncertainty behaviours for 1,464 infractions at Strasbourg (i.e. 5.46%) whilst 38 uncertainty behaviours were observed for 369 infractions at Nagoya (10.29%), which is different (chi^2=11.4, p<0.001). The gender of the pedestrian had no effect on the likelihood of hesitating while crossing against a red light in either country (chi^2<0.48, p>0.490). For the age variable, a zig-zag product on the likelihood of hesitating was observed on the graph for Japanese pedestrians. This is probably due to the small dataset with uncertainty behaviours. The age graph for French pedestrians seemed more coherent, with the highest number of uncertainty behaviours recorded for 20-year-old pedestrians and the lowest for their 60-year-old counterparts (Figure 2). The tendency to hesitate (K-s test, W = 6074, p-value = 0.06178) was observed in the first pedestrians to cross the road in France (average±stdv=1.8±1.2), whilst the same tendency was shown by pedestrians following individuals who had already started crossing in Japan (average±stdv=2.2±1.6). We observed ten hesitating individuals using their phones (8.4% of hesitating individuals), which is no higher than the rate of individuals using their phones whilst crossing at a red pedestrian light (8.6%).

The uncertainty time GLM showed that this dependent variable is influenced by the country (Table 2, z=2.134, p=0.033), by being accompanied (z=2.526, p=0.012) and by the [country*accompanied] interaction (z=2.087, p=0.037). Uncertainty time appears to be longer in Japan, and longer when the pedestrian is alone in both countries, but more importantly this last effect is enhanced in Japan (i.e. a stronger effect was observed in Japan, with longer uncertainty times when alone). Other factors (see Table 2) did not affect the time of uncertainty.

b) Factors affecting subsequent behaviours

After the 118 scored uncertainty behaviours, pedestrians showed 90 abandons (76.3%) and 28 accelerations (23.7%). Abandoning a crossing therefore appears then more probable than accelerating. Surprisingly, the percentage of accelerations is higher in Japan compared to France (34.2% and 18.7%, respectively). The GLM for the types of subsequent behaviours (abandoning or accelerating, Table 3) showed that only the number of lanes [2x1] is significant ($z=3.445$, $p=0.001$): the abandon rate increased with the number of lanes, whilst the acceleration rate decreased (Figure 3). Due to our small sample size, we did not obtain a significant effect for [2x2] and [2x3] lanes (where only abandon behaviours were observed). Concerning the departure order ($z=1.682$, $p=0.093$), a Spearman correlation test on the percentage of abandons/accelerations according to the pedestrian departure order revealed that the relative number of abandons decreases with the departure order, whilst the relative number of accelerations increases ($rho_{abandon}=-0.86$, $rho_{acceleration}=0.86$, $p=0.026$, Figure 4).

DISCUSSION

This study highlights the factors influencing the uncertainty behaviour of pedestrians crossing against the red light and the subsequent behaviours, namely abandoning or accelerating the crossing. Japanese citizens are known to respect social rules more than French or even western citizens (Benedict, 2005; Komiya, 1999; Markus and Kitayama, 1991; Ito, 1989). These cultural differences are not explained by differences in environmental factors but rather by the emergence of social conventions (Centolla and Baronchelli, 2015). A previous study showed that only 2.1% of crossings at signalized intersections are illegal in Japan, compared to 41.9% in France (Pelé et al., 2017). However, only 5% of French pedestrians showed uncertainty behaviours when crossing against the red light, compared to 10% of the Japanese pedestrians. It is important to note that it was impossible to carry out observations of a road with 3*2 lanes in Strasbourg to compare with our observations in Nagoya. This limitation could decrease the ratio of illegal crossings and the ratio of uncertainty behaviours in Japan compared to France.

The uncertainty time is also longer in Nagoya (Japan, 1.55±1.45 s) than in Strasbourg (France, 1.22±0.97 s). These two elements –higher rate and longer time in Japan - lead us to suggest that Japanese pedestrians who crossed illegally mostly did so by following other pedestrians. Indeed, hesitating seems to occur in Japan when a pedestrian follows others already crossing against the red light (rather than due to inattention from using their phone, see explanations below) then realises the misevaluation. Pelé et al. (2017) have already described this phenomenon in Japanese pedestrians. Indeed, pedestrians show a strong mimetism by following social information when they cross the road, sometimes inadvertently crossing against the red light (Faria, 2010; Pelé et al., 2017). This could explain why surprised pedestrians hesitate when they realise that they are crossing illegally. The information they obtain after starting to cross might be personal (by checking the light colour or seeing a car arriving) or social (noticing that other pedestrians do not cross). These conclusions may be confirmed by the fact that accompanied pedestrians in Japan showed a lower uncertainty time than pedestrians who crossed alone: the accompanied pedestrian could be therefore helped by social information. These results and previous findings (Pelé et al., 2017) confirm a strong inter-country difference in the causes of illegal road-crossings and the causes of uncertainty behaviour. Pelé et al. (2017) showed that whilst most pedestrians deliberately cross against the red light in France, they appear to do so accidentally in Japan.

Many studies have shown an age and gender effect on crossing behaviours (Tom and Granié, 2011; Holland and Hill, 2007; Oxley et al., 1997). However, no such effects were observed in our study for the uncertainty behaviour rate, or for the uncertainty time and its possible subsequent behaviours. We suggest that this absence of effect may be due to two consecutive indirect filters resulting from our hesitating pedestrian population and linked to the data set: we studied uncertainty behaviours in a population of individuals who showed such behaviours (compared to those who did not show them). In turn, this population was part of a larger population of individuals: those crossing at a red light (compared to those who crossed at the green light). We assume that these two consecutive filters resulting from our dataset could lead us to solely observe pedestrians presenting a certain level of risk taking. For instance, women and/or elderly pedestrians, known to take fewer risks than men or adolescents (Sueur et al., 2013; Faralla et al., 2013; Wilson and Dally, 1985) did not cross at the red light or rarely did so, thus could bias the dataset and providing non-significant results for age and/or sex effect on uncertainty. We also expected men to display more accelerations than women, but this gender effect does not appear to be statistically significant, again probably due to the aforementioned filtering. We checked this filtering hypothesis in our dataset: this was checked with Japan pedestrians but not with French ones. Indeed, we observed a change in gender-ratio between total crossings and illegal crossings and between illegal crossings and uncertainty behaviours in Japan but this was not the case with France (see Table 4). Considering a possible age effect, we expected more uncertainty behaviours from the youngest (10-year-old) and oldest (more than 60-year-old) pedestrians than in other age categories. However, the results were inconsistent in Japan (Figure 2a) and were unexpected in France (Figure 2b), with 20-year-old French pedestrians showing the highest rate of uncertainty behaviours and 60-year-old pedestrians displaying the lowest rate of uncertainty behaviours. This result may be explained by our low sample size, but we cannot exclude the possible effect of decreasing cognitive abilities with age (Brown and Ott, 2004; Farias et al., 2005; Iosa et al., 2014; Salthouse, 1996), responsible for a lack of reaction or absence of uncertainty behaviour in the elderly when in risky situations (Holland and Hill, 2007; Oxley at al., 1997).

Whilst we did not observe an effect of environmental variables on the uncertainty time, we did observe an effect on the probability of an acceleration or abandon behaviour after uncertainty. A higher number of lanes resulted in a decrease in the probability that a pedestrian would accelerate and an increase in the probability that they would abandon the crossing. Only abandon scenarios were displayed by pedestrians illegally crossing roads with six lanes (three lanes in each direction). As the number of lanes increases, the number of vehicles and subsequently the risk of accidents increases. Thereby, abandoning the crossing appears to be a safer behaviour for pedestrians than accelerating. Indeed, we decrease our perception abilities when rushing, and we thus increase the probability of an error of judgement. This processing-speed theory (Salthouse, 1996) - where accuracy of decisions decreases with speed (Pelé and Sueur, 2013; Nagengast et al., 2011; Sueur and Pelé, 2015) - has been well demonstrated for driving speed but can also be confirmed in pedestrians (Aarts and Schagen, 2006; Kloeden et al., 2002; Kloeden et al., 2001).

Our results also show that the probability of abandoning decreases with the departure order of the pedestrian (i.e. with the number of pedestrians who have already crossed or started crossing) while the probability to accelerate increases. This mimetic effect is due to conformity bias (Cialdini and Goldstein, 2004), and increases the risk of being injured or killed. Referred to as “sheep” or “herd” behaviour, this copying behaviour is well known in human beings in domains such as financial markets, fashion, purchasing or crowd behaviour (Banerjee, 1992; Bikhchandani et al., 1992; Chen, 2008; Hirshleifer et al., 2003; Mawson, 2005; Raafat et al., 2009). It seems to be deeply rooted in human behaviour due to the gregariousness and sociality of the human species, and can be observed in many other social animal species (Couzin and Krause, 2003; King and Sueur, 2011; Krause and Ruxton, 2002). However, it may also reflect a sense of safety in numbers; car drivers are more likely to see a group and are hence more likely to slow down or stop, even if they have right of way (Harrell, 1991; Rosenbloom, 2009).

Finally, contrary to what we expected and what has been described in the literature (McKnight and McKnight, 1993; Neider et al., 2010; Strayer et al., 2003), we did not observe a decrease in attention when pedestrians were using a phone. Only ten hesitating individuals were observed using their phone (8.4% of the sample size). This does not seem no higher than the rate of individuals using a phone whilst crossing against the red light (8.6%), and these pedestrians did not show a higher uncertainty time than other pedestrians. The rate recorded in our study is lower than the 20% of distracted pedestrians found by Bungum and colleagues (2005). Again, this result may be due to the low sample size caused by the double filtering (see above).

Overall, combined with the findings of previous studies (Pelé et al., 2017), these results indicate the existence of two categories of rule breakers among pedestrians, namely those who deliberately do so (as described in Pelé et al. 2017) and those who do so inadvertently (shown here through uncertainty behaviour). This second category appears to represent the most vulnerable pedestrians, because they seem to misevaluate a safety crossing. Additional signals could be set up to provide more adequate protection of pedestrians at accident-prone intersections. Sound signals have already been set up to help impaired or blind people (Tauchi et al., 2000; Tauchi et al., 1998). In our case, we could imagine less pleasant signals such as the new water spray systems that surprised rule-breaking pedestrians in China's Hubei Province (BBC News). Further research will then be needed to measure the success rate of such innovative systems in saving lives.

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TABLES

Table 1: Details concerning the studied sites in Strasbourg (France) and Nagoya (Japan). A total of 80 and 38 uncertainty behaviours were observed in France and in Japan, respectively, on the lines “Number of uncertainty behaviours counted during 6 hours of observation”. Pictures of the different intersections are available in the Supplementary Material section of Pelé et al. 2017, via this link: https://doi.org/10.6084/m9.figshare.c.3677176.v1

Strasbourg-France				
Sites	Train Station	Pont des Corbeaux	Place Broglie	
Coordinates	48.584474, 7.736135	48.579509, 7.750745	48.584559, 7.748628	
Number of lanes in each direction	1	2	1	
Mean pedestrian flow per hour	667	612	850	
Mean road-crossing speed (m.s-^{1})	0.96±0.05	1.11±0.29	1.01±0.16	
Data collection dates	02/07-07/07/2014	01/10-25/10/2014	15/02-09/03/2015	
Number of uncertainty behaviours counted during 6 hours of observation	36	23	21	
Percentage of illegal crossings	58.29%	32.92%	44.02%	
Nagoya-Japan				
Sites	Train Station	Maruei	Excelco	Osu-Kannon
Coordinates	35.170824, 136.884328	35.168638, 136.905740	35.166891, 136.907284	35.159316, 136.901697
Number of lanes in each direction	3	one-way street	1	1
Mean pedestrian flow per hour	480	645	869	814
Mean road-crossing speed (m.s-^{1})	1.10±0.22	1.15±0.21	0.98±0.21	1.07±0.18
Data collection dates	13/06-05/07/2011	27/01-05/02/2015		
Number of uncertainty behaviours counted during 6 hours of observation	3	15	4	16
Percentage of illegal crossing	8.34%	14.53%	2.11%	8.86%

Table 2: Results of the model selection (see statistical analyses section) with the uncertainty time (in seconds) as a dependent variable. Considering the number of lanes, the reference chosen is [1x1].

Independent variables	**Estimate**	**Std. Error**	**Adjusted SE**	**z value**	**Pr(>|z|)**
(Intercept)	0.869	0.281	0.284	3.064	0.002
Accompanied [Yes]	-0.733	0.288	0.290	2.526	0.012
Country [France]	-0.629	0.292	0.295	2.134	0.033
Accompanied [Yes]* Country [France]	0.660	0.313	0.316	2.087	0.037
Number of waiting pedestrians	-0.014	0.014	0.014	1.033	0.302
Gender [Man]	-0.105	0.191	0.193	0.543	0.587
Number of lanes [2x1]	0.368	0.286	0.289	1.275	0.202
Number of lanes [2x2]	0.478	0.323	0.326	1.465	0.143
Number of lanes [2x3]	-0.224	0.487	0.493	0.455	0.649
Using a phone [Yes]	-0.157	0.260	0.263	0.595	0.552
Age	-0.003	0.005	0.005	0.547	0.584
Departure Order	-0.005	0.054	0.054	0.099	0.921
Gender [Man]*Country [France]	-0.200	0.303	0.306	0.652	0.514

Table 3: Results of the model selection (see statistical analyses section) with the type of behaviour following uncertainty as dependent variable (abandon = 1, acceleration = 0).

Independent variables	**Estimate**	**Std. Error**	**Adjusted SE**	**z value**	**Pr(>|z|)**
(Intercept)	-0.574	1.067	1.075	0.534	0.593
Number of lanes [2x1]	2.882	0.829	0.837	3.445	0.001
Number of lanes [2x2]	0.625	0.874	0.883	0.708	0.479
Number of lanes [2x3]	17.015	1377.357	1392.471	0.012	0.990
Departure Order	-0.303	0.178	0.180	1.682	0.093
Age	0.023	0.018	0.018	1.273	0.203
Gender [Man]	0.648	0.550	0.556	1.166	0.244
Number of waiting pedestrians	-0.054	0.050	0.051	1.072	0.284
Country [France]	0.670	0.832	0.841	0.797	0.425
Using a phone [Yes]	0.490	0.984	0.995	0.492	0.623
Accompanied [Yes]	-0.179	0.558	0.563	0.319	0.750

Table 4: Relative percentage of men and women in France and Japan according to the total crossing (at red and green light), the illegal crossing (red light) and the uncertainty behaviours.

		Total crossing	**Illegal crossing**	**Uncertainty behaviours**
France	Men	44.4	44.4	46.25
	Women	55.6	55.5	53.75
Japan	Men	42.2	59	42.1
	Women	57.7	41	57.9

FIGURE LEGENDS

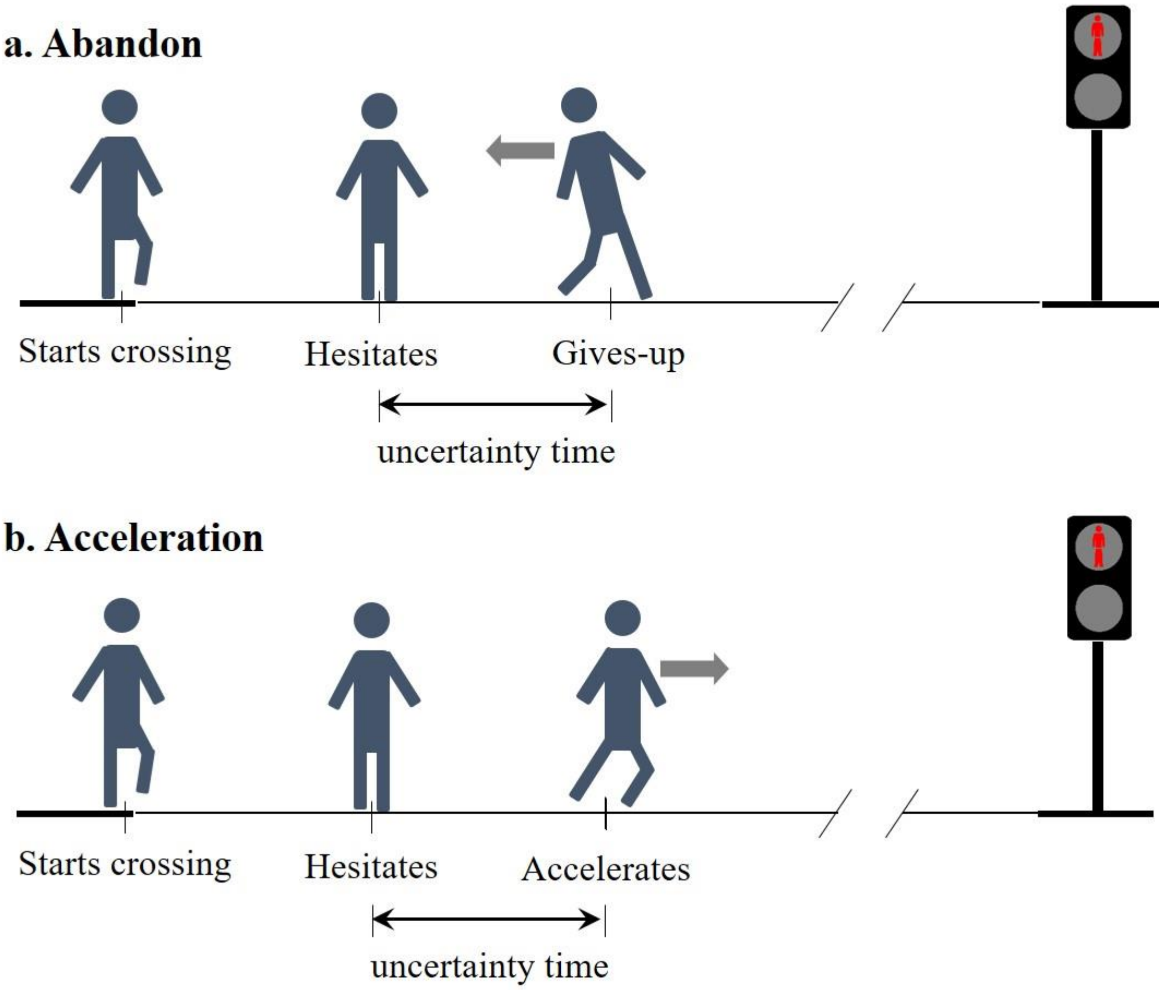

Figure 1: Temporal scheme of the different behaviours scored in this study.

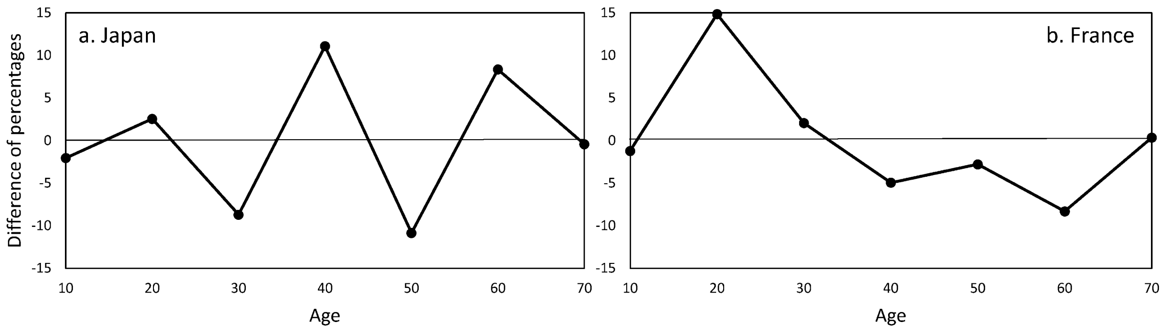

Figure 2: Differences in the percentages of 118 pedestrians showing uncertainty behaviours (N= 80 for France and N= 38 for Japan) and 1,278 pedestrians of a sample size (N=551 for France and N= 727 for Japan) in a. Japan and b. France. Positive values showed that more pedestrians in a given age category showed uncertainty behaviour than expected; negative values showed that fewer pedestrians in a given age category showed uncertainty behaviour than expected.

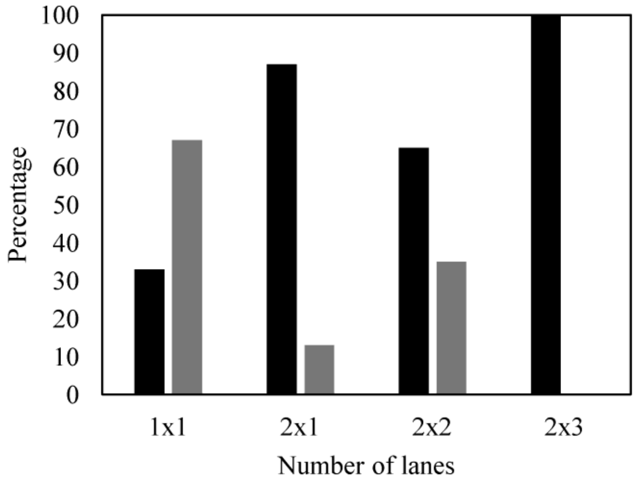

Figure 3: Percentage of abandons (black bars) and accelerations (grey bars) according to the number of lanes.

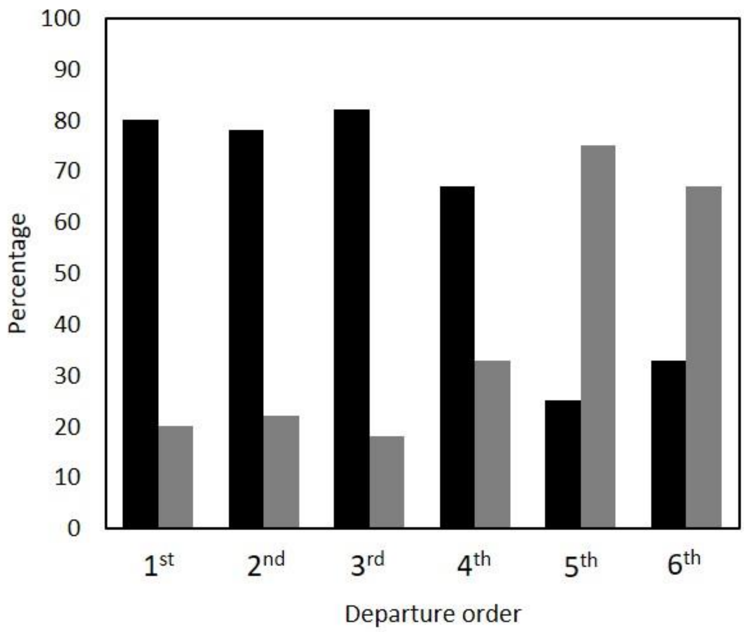

Figure 4: Rate of abandonment (black bars) and acceleration (grey bars) according to the departure order of the pedestrian.