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Crossing time of older cyclists at signalised junctions

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Abstract: Several studies have demonstrated that many older pedestrians are unable to cross a road with pedestrian signals in time. In the present study, we observed cyclists crossing two traffic light-controlled junctions, and measured their crossing time. We found that older cyclists need more time to cross the road than younger cyclist, even more than allotted, in the sense that the opposite side of the road is frequently reached while the light has turned red and the “all red phase” just ended. It is concluded that traffic light cycle phases may need to be reviewed.

Keywords: age; ageing; crossing; cycling; elderly; junctions; traffic light.

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1 Introduction

People nowadays grow quite a lot older than they did 50 years ago. In 2004, about 13.8% of the population was 65 years of age or older in the Netherlands. By 2014, this percentage was 17.3 (Eurostat, 2015). The proportion of older people will definitely continue to increase. This part of the population is nowadays more used to being mobile,

and is also increasingly being required to stay mobile because reduced mobility in old age has consequences in terms of reduction in social integration, life-satisfaction, well-being and mental fitness, all of which may lead to isolation and depression (Marottoli et al., 1997; Cass, Shove and Urry, 2005; Webber, Porter and Menec, 2010). Consequently, fostering independence and mobility is highly relevant for an ‘ageing society’ that wants to remain healthy and sustainable.

Though participation in traffic is crucial for mobility, it has to be safe both for the vulnerable older road users and for others. Although many older people continue to drive a car, the number of elderly who participate in traffic as pedestrians or cyclists is growing (Van Boggelen, 2011). The problems these older people encounter are often related to reduced vision, reduced hearing, increased reaction time and reduced motor performance (Ivers, Mitchell and Cumming, 1999, Tiedemann, Sherrington and Lord, 2005). In this respect, the present traffic infrastructure may not be best suited for older people. In Ireland and Spain, Romero-Ortuño (2010) and Romero-Ortuño et al. (2010) found that older pedestrians did not have enough time to reach the other side of the road; the traffic light turned red when they were still crossing. Asher et al. (2012) found similar results and came to the same conclusion. The obvious reason for this is that older pedestrians cross at lower speeds (see Avineri, Shinar and Susilo, 2012). Technological countermeasures could be taken to allow for safe crossing; for example, in the Netherlands a pedestrian crossing light that increased the crossing time for seniors after being detected by radar and video was installed in the city of Tilburg (Mevius and Kievits, 2010).

In an ageing society, the question arises whether similar problems with crossing a junction can be observed in older bicyclists, and whether they are able to reach the opposite side without (potential) conflicts with other traffic participants. Older cyclists on conventional bicycles ride at a 20% lower speed than young cyclists (Abou-Raya and Elmeguid, 2009). In some cases, this may lead to unintentional red light running. It has been shown that red-light running is a strong predictor for traffic accidents, specifically of older cyclists (Hagemeister and Teglen-Klebingat, 2011).

Collisions with passenger cars make up to 52% of the total number of cyclist’s deaths in the European Union (Adminaite, Allsop and Jost, 2015). In general, the most vulnerable group of cyclists are people above 65 years of age (Bíl, Bílová, and Müller, 2010, Adminaite, Allsop and Jost, 2015). Fragility plays an important role in the higher fatality rate, although Maring and Van Schagen (1990) add that changes in overall cognitive and perceptual processing leading to slower reactions to imminent danger are very important as well. Asher et al. (2012) stress that insufficient crossing time for pedestrians does not necessarily increase the risk of being involved in an accident, but does deter pedestrians from trying to cross. For cyclists, this may mean avoiding certain junctions, and may even discourage older cyclists from using their bicycles at all. Also, at locations where they do cross, slower speed may bring them into a situation where other traffic is allowed to start driving and may come into conflict with them.

In the present study, crossing behaviour of cyclists was recorded at two signal-controlled junctions. Crossing time of younger cyclists was compared with that of older cyclists. The hypothesis evaluated is that older cyclists need more time to cross a junction. The study setup had been approved in advance by the Ethical Committee of the Department of Psychology of the University of Groningen.

2 Method

2.1 Locations

Crossing behaviour of cyclists was observed at two junctions in the city of Groningen. At both locations, separate cycle paths and separate bicycle traffic lights were installed. The first location is depicted in Figure 1 and the second location is shown in Figure 2. The difference between the two locations was that at Location 2 cyclists turning right had a separate small lane and did not have to stop for a red light. However, only cyclists crossing the intersection and cycling straight on were included in the sample.

Figure 1 Location 1 (see online version for colours)

Figure 2 Location 2 (see online version for colours)

The distance from the stop line to the opposite side was 29.5 m on Location 1, and 34 m on Location 2. Both locations were selected because of the relatively large proportion of elderly inhabitants in those areas, and both were North–South (relatively) busy arteries leading to and from the city centre. Both junctions did not have what is called ‘green-

for-all cyclists at the same time'. Green-for-all is a common condition in Groningen where cyclists from all directions get a green light at the same time and have to yield to traffic from the right. That type of junction is different from more general junctions, and the green light for all regulation is likely to affect crossing time to a large extent.

At both locations, 3 hours of footage was recorded, only on rain- and snow-free dates between December 2013 and February 2014.

2.2 *Material and scoring*

The video recordings were made with a JVC-camcorder, model GZ-MS150HE. Behaviour of younger (estimated age 15–30 years) and older (estimated age 65 years or older) was scored. As the ages were only estimated, the age gap between the two groups was made large - 35 years - to avoid misclassification as much as possible. Behaviour of cyclists of other ages was not scored.

The traffic light cycle differed between and even within locations, based on traffic density. At the locations, the green phase for cyclists varied between 3 and 28 seconds, but the amber phase was always 3 seconds. Taken together, these two phases are referred to as available pass time, even though the actual safe pass time is somewhat longer as there is an 'all red phase' of (often) only 1 second. The crossing time of cyclists was scored as follows:

- 'Start time'; time (in seconds) that has elapsed after the signal turns green before the cyclist passes the stop line on the starting side. This measure was scored separately as this time is different for the cyclist in front or in the centre of the queue, and for cyclists approaching a green light while cycling.
- 'Crossing time'; the time (in seconds) from passing the stop line to reaching (a fixed point at) the opposite side of the junction.
- 'Pass time'; the time the traffic light for bicyclists is Green and Amber, in other words, the time available to pass the junction.

Start time actually should not be of influence on being able to cross, i.e. as long as cyclists pass the traffic light at green. However, it is likely that it does affect crossing time. All parameters are listed in Table 1.

Table 1 Measures

<i>Crossing time</i>	=	<i>Time on junction</i>
Start time	=	Time needed to pass the stop line after green
Green phase	=	Time the traffic light was green
Amber phase	=	Time the traffic light was amber
Pass time	=	Green phase + Amber phase
Given pass time	=	Pass time – Start time
Colour light after crossing	=	Whether the traffic light was red when reaching the opposite side of the junction

The ‘all red phase’ at Location 2 was variable (depending amongst others on whether the pedestrian crossing light was manually operated), but was frequently quite brief, about 1 second for turning motorised vehicles coming from the opposite direction that pass the first half of the junction just crossed by cyclists. In practice, this meant that cars passed this section within 4–5 seconds after the bicyclist’s light just turned red. The latter, a 5-second delay before cars crossed the cycle path, was also observed at Location 1.

Data were analysed with SPSS 20, crossing time is the main dependent variable and age group and junction are independent variables.

3 Results

In Table 2, the averages of the observed time units are displayed.

Table 2 Range, averages and standard deviation (all in seconds) of green phase, given pass time, start time and crossing time (see Table 1) per junction for all scored bicyclists

<i>Location 1 (N = 148)</i>	<i>Range min–max</i>	<i>Average</i>	<i>Standard deviation</i>
Green phase	3–15	8.04	2.12
Amber phase	3–3	3.00	-
Pass time	6–18	11.04	2.12
Start time	0–13	3.84	2.03
Given pass time	1–15	7.19	2.52
Crossing time	6–11	8.10	1.31
<i>Location 2 (N = 73)</i>			
Green phase	4–28	13.45	7.92
Amber phase	3–3	3.00	-
Pass time	7–31	16.45	10.92
Start time	0–9	1.22	1.75
Given pass time	5–31	15.40	7.78
Crossing time	8–15	10.52	1.63

To evaluate the hypothesis, ‘older cyclists need more time to cross a junction’, crossing time per group and per location was determined, because the junctions differed in dimensions. In Figure 3, the average crossing times are displayed. It is clearly visible that older cyclists need more time, 0.8 seconds extra on Location 1 and 1.5 seconds extra on Location 2 (10–15% more time). Crossing time is also more variable among older cyclists, in particular at Location 2. Statistical evaluation was completed with an analysis of covariance (ANCOVA) with start time as covariate and showed significant effects for age (Table 3).

The results show main effects for age group at both locations, but not for start time. Related to a slower crossing time is the expectation that the moment older cyclists reach the opposite side of a junction the traffic light will be more often red than for younger cyclists. Figure 4 illustrates that this is indeed the case, in particular on the larger junction at Location 2 (overall $\chi^2_{df=1} = 9.562$, $N = 232$, $p = 0.002$ [single sided test];

Location 1 $\chi^2_{df=1}=2.629$, $N=149$, $p=0.073$ [single sided], Location 2: $\chi^2_{df=1}=6.097$, $N=83$, $p=0.015$ [single sided]). However, at Location 1, fewer cyclists of both age groups managed to complete the crossing at green or amber light when compared with Location 2, where most young cyclists did manage ($\chi^2_{df=1}=12.406$, $N=232$, $p=0.001$).

Figure 3 Crossing time per location. Error bars reflect standard error. Location 1: $N_{\text{young}}=90$, $N_{\text{older}}=58$; Location 2: $N_{\text{young}}=54$, $N_{\text{older}}=19$ (see online version for colours)

Table 3 Effect of age group and start time on crossing time

<i>Location 1</i>	<i>F-value</i>	<i>df</i>	<i>p</i>
Complete model; age group adjusted for start time	5.83	3, 144	$P \leq 0.001$
Main effect: age group	8.48	1, 144	$p \leq 0.01$
Main effect start time	<1	1, 144	NS
Interaction age $\times$ start time	1.42	1, 144	NS
<i>Location 2</i>			
Complete model; age group adjusted for start time	5.56	3, 69	$p \leq 0.01$
Main effect: age group	14.23	1, 69	$p \leq 0.001$
Main effect start time	<1	1, 69	NS
Interaction age $\times$ start time	<1	1, 69	NS

Figure 4 Percentage of bicyclists that reached the opposite side of the junction with the traffic light turned red at the moment of arrival. $N = 232$ (see online version for colours)

The expected effect of start time (i.e., time needed to pass the stop line) was not found. An explanation for this could be that cyclists who have a longer start time, also have a longer crossing time. Correlation of these two parameters however is negative (for all cyclists: $r = -0.311$, $p < 0.001$, $N = 221$, for the group older cyclists: $r = -0.391$). Pass time available (given pass time) and crossing time correlate positively with each other ($r = +0.346$, $p < 0.001$), which may be an indication that people cycle slower if they have more time to cross the junction.

4 Discussion and conclusion

Older cyclists with an estimated age above 65 years need, on average, about 10–15% additional time to cross a junction than cyclists with an estimated age between 15 and 30 years. Main effects for age were found at both locations. The finding that on average 50% of the cyclists reach the opposite side in time while their traffic light turned red is only a problem if the ‘all red phase’ is too brief. Even though at the observed location this all red phase was brief, it did not lead to problematic encounters as cyclists were further than half way across the junction when cars crossed the first half. Still, the margins are limited, and if cars accelerate faster and/or cyclists cross at slightly slower speed this could become problematic. The latter actually was recently found to be the case at another junction (Hutten, 2015). This may mean that green and amber phases for cyclists need to be extended, or alternatively that the all red phase should be extended. In an ageing society the problem of potential conflicts is more likely to increase than to decrease.

The present study has a few limitations. First of all, only two junctions were selected. The traffic lights at these junctions have different properties from many other junctions in the city of Groningen, where a ‘green for all cyclists at the same time’ has become very popular. In most other countries this green-for-all has not been introduced, and because the behaviour of other cyclists at these junctions directly affects crossing time, the two

studied junctions were selected. The second limitation is that the behaviour was scored from video and that the age of the cyclists was only an estimate. Estimating age on the basis of looks can go wrong, so a large intermediate age group (30–65 years of age) was not scored but left out of the analyses. It would however be interesting to be able to subdivide the older participants in young-, intermediate- and old-older bicyclists to see whether Crossing Time increases and to what extent, particularly as retaining mobility for older people is important. Third limitation is that the colour of the traffic light for other traffic could not be observed from the perspective of the video registration viewpoint. In future studies it would be useful to have this information available, so it can be better seen whether situations actually become dangerous. The final limitation was that the type of bicycle used could not be accurately assessed. With the increase in electric bicycles (Schepers et al., 2014, Langford, Chenb and Cherry, 2015, Fyhri and Fearnley, 2015) Crossing Time and, in particular, Start Time could decrease (Fishman and Cherry, 2015), which would make the readaptation of the traffic light cycle less urgent.

Future studies could try to replicate findings at other locations, as the present locations were selected because of a relatively large proportion of elderly inhabitants in these two districts. Also remarkable is the variance in traffic light settings such as green phase, which differ not only between but also within locations, so as to optimise flow. These factors make extrapolation of results difficult. Further useful information might be obtained from emergency units and insurance companies, as to how many accidents actually are the result of a too brief passing time for older cyclists.

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