How do healthy older pedestrians walk when they cross the street ?

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1. Introduction

About 54% of pedestrians killed on French roads are over 60 years old (ONISR, 2012), whereas this age group represents less than 24% of the French population (INSEE, 2013). Factors such as slowdown of decision-making, reduction of walking speed, and difficulty of adopting sufficient safety margins can explain that over-representation of older pedestrians in traffic accidents (e.g. Lobjois & Cavallo, 2007). Other studies show that older people are capable of taking appropriate safety precautions. For example, Harrell (1991) described older pedestrians as a safe age-group in a study involving pedestrians waiting to cross at signal-controlled intersections. More recently, a self-reported data collected by Granié *et al.* (2013) revealed that older pedestrians are in fact the safest aged group. On the other hand, as motion analysis is often used to better analyse and understand human walking, it would be interesting to apply that method for the study of elderly people's behaviour during road crossing.
This paper aims at presenting a study of road crossing behaviour of senior pedestrians through a 3D analysis of movements using a road crossing simulator. Unlike most of the previous studies on pedestrian's behaviour, our main hypothesis is that older people in good shape adopt appropriate behaviour when crossing the street.

2. Method

The sample was composed of 12 older participants (67 ± 7 years old) and 12 young participants (23 ± 2 years old), all in good shape. As older group satisfied the selection criteria (i.e. autonomous and active person; no disease or medication which may influence the task studied), it can be considered that they represented the « successful aging » (Gangbè & Ducharme, 2006).
The road crossing task took place in a road crossing simulator. This simulator reproduced a two-way street in which the participant could walk and realize a half-crossing (see Delzenne, 2013).
Each participant initiated crossing with the right foot and realized 30 successful trials under conditions of varying difficulty (i.e. two heights of curb; three conditions of increasing traffic difficulty).

In order to study the pedestrians' walk progression, a morphological analysis of curves was performed. Sagittal plane joint kinematics of hip, knee, and ankle were quantified using the gesture analysis Vicon Nexus 1.4.114 software. The parameters were the maximum plantar flexion during the pre-swing phase and the maximum flexion of the hip and knee during the swing phase. The crossing speed was also calculated from the right-heel-off marking the road crossing initiation to the beginning of the third step. The walking speed outside the simulator was taken three times during the 6-minutes walking test in order to determine the speed at which each participant was able to move.
The data were analyzed using t-Student and Mann-Whitney tests.

3. Results

Figure 1 shows the results of gait speed inside and outside the simulator.

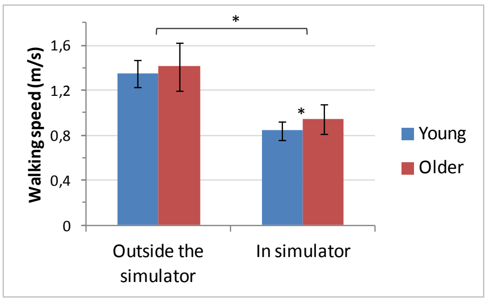

Figure 1: Mean walking speed in and outside the simulator for the older and young groups (* : $p < 0.05$).

Unlike the literature results, walking speed outside the simulator did not differ significantly between the two age-groups: the old and the young participants walked at the average speed of 1.41 ms^{-1} and 1.35 ms^{-1}, respectively. The results show that outside the simulator, the older age-group could walk at the same speed as the younger one. Walking speed of all the participants inside the simulator was significantly lower than that of outside. However, the older age-group crossed the street faster than the young participants (p <0.05). This result might reflect seniors' desire to minimize time spent in real road crossing situation to reduce any risk of collision.

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Despite the observed road-crossing speed of the older participants, the 3D movement analysis showed that, whatever the condition, the maximum plantar flexion of the older group was lower than that of the younger participants (Figure 2). This result is consistent with the literature on human walking. Nevertheless, the older participants increased significantly their knee flexion in order to reduce their plantar flexion.

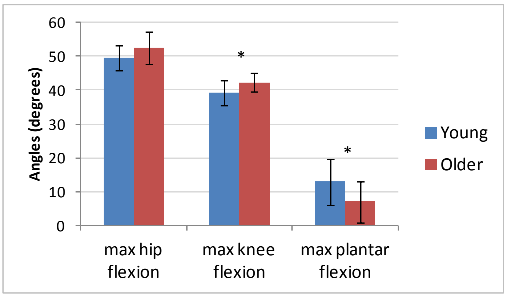

Figure 2: Hip, knee and ankle kinematics for the older and young groups. (* : $p < 0.05$).

4. Conclusion

Our study aimed at better understanding the over representation of older pedestrians in traffic accidents, but the results show that the seniors in good shape tend to adopt appropriate behaviour when crossing the street. Moreover, they compensate their small plantar flexion by increasing knee flexion in order to limit the risk of tripping. Future works will thus continue on that topic in order to increase knowledge and bring solutions.

5. Acknowledgments

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