Automated Shuttles as Traffic Calming: Evidence from a Pilot Study in City Traffic

Amélie Huot-Orellana, Nicolas Saunier

Civil, Geological and Mining Engineering Department
Polytechnique Montréal
2500 Chemin de Polytechnique, H3T 1J4, Montréal, QC, Canada
Emails: amelie.huot-orellana@polytml.ca, nicolas.saunier@polymtl.ca

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1 INTRODUCTION

Discourse about the real-world effects of automated vehicles has intensified over the last decade, but few observational studies have been made examining their integration in real traffic. This research is based on the dataset prepared by Beauchamp et al. in [1] where video footage from two pilot projects involving automated shuttles in Montreal and Candiac in 2019 was analyzed to compute safety indicators from road user trajectories. The study showed that automated shuttles have safer interactions with other road users compared to human drivers following the same trajectories.

Yet, this may not be the only characteristic of automated shuttles. These vehicles are notoriously slow, 10 to 15 km/h slower than human-driven cars in city traffic [1], which on city streets is bound to influence other road users, in particular following cars. It is therefore hypothesized that automated shuttles may have a traffic calming effect, slowing other motorized vehicles [2]. Slower speed and the predictability of automated shuttles, obeying the rules of the road and yielding more willingly to vulnerable road users (pedestrians and cyclists) may also have an impact on these users' behavior [3]: for example, cyclists may pass the shuttle, pedestrians may cross outside of crosswalks. The present study aims to explore the potential effects of automated shuttles, with their slower speeds and more predictable behavior, on the behavior of other road users.

2 METHODOLOGY AND EXPERIMENTAL RESULTS

This work relies on the extracted trajectory data from the study of Beauchamp et al. [1], where the trajectories of all road users were extracted for more than 70 hours on seven sites along the shuttle routes, three in Montreal and four in Candiac (south shore of the Island of Montreal). The exploratory analysis presented in this paper relies on 2 hours and 40 min of observations at two sites in Montreal. Road user speeds and accelerations are compared by category of road user, depending on the presence of the automated shuttle and the time since it passed. Various statistics of each individual road user trajectory can be extracted: the mean speed, as well as the 15th and 85th centiles of acceleration, are computed for each road user. The 15th and 85th centiles of acceleration are generally negative and positive respectively, corresponding to "extreme" braking and "accelerations" by each road user as it passes in the camera field of view.

The mean speeds are show in Figure 1 for two sites in Montreal. The first boxplot in each sub-graph (indexed by "0") corresponds to the speeds of each category of road user for road users in the presence of the automated shuttle. In both sites, the mean speeds of cars (the medians and most of the other quartiles) are lower than for time intervals after (e.g., the $]0-1]$ interval corresponds to the mean speeds of cars passing between 0 and 1 min after the shuttle). This would be consistent with a calming effect on cars that must interact with the automated shuttle. There are few observations for other road users at the second Montreal site (Ontario). For cyclists at the Coubertin site, the trend seems different, with higher speeds for cyclist interacting with the shuttle. The speeds of pedestrians do not seem to change depending on the presence of the shuttle, except for reduced variability as measured by the interquartile range (but the sample size is the smallest for pedestrians in the presence of the shuttle).

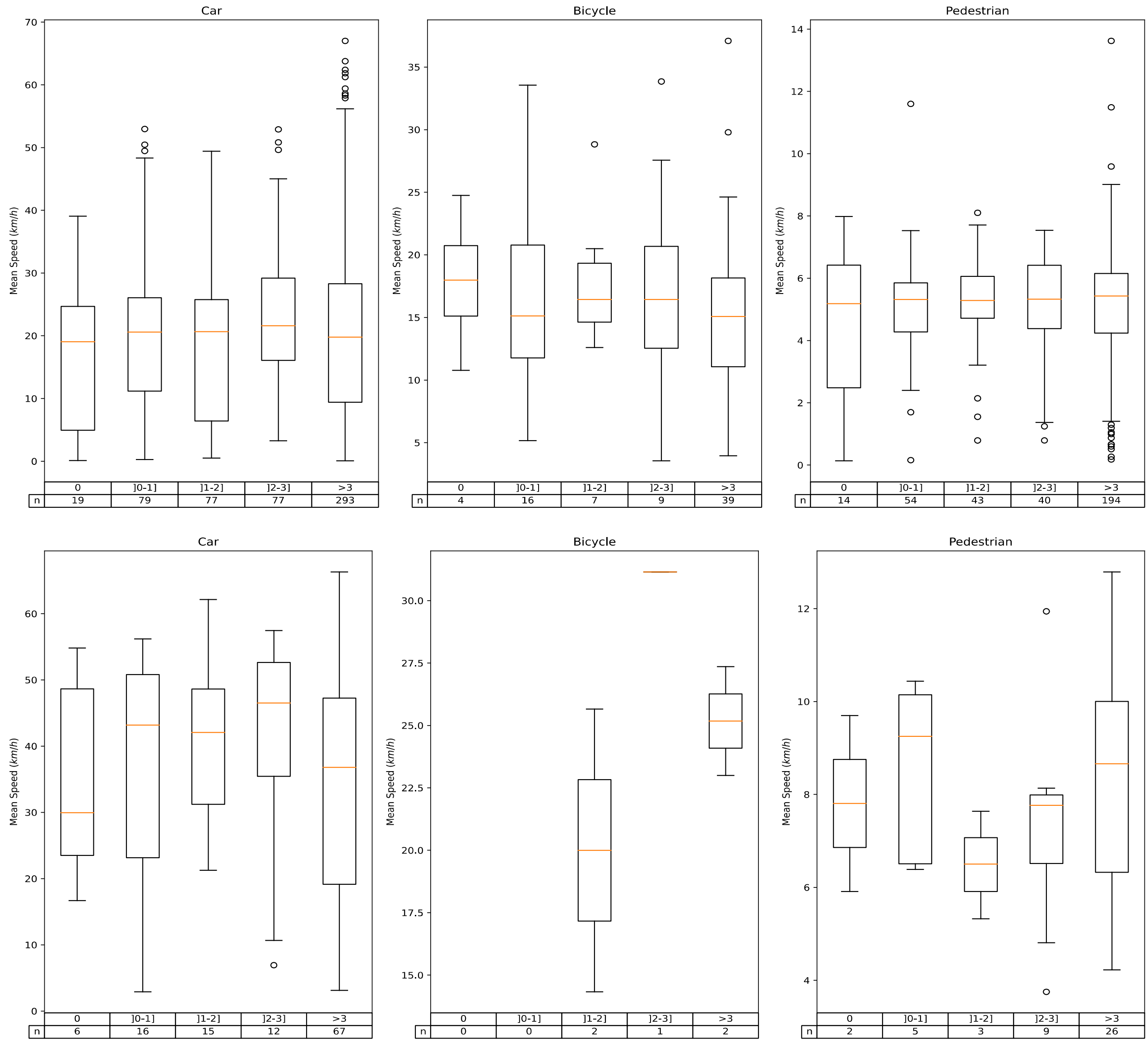

Figure 1 Boxplots of mean user speed per category of road user for different time intervals (in min) since the shuttle passed ("0" means the shuttle was present when the road user passed) at the Coubertin (top) and Ontario (bottom) sites in Montreal (n in the table denotes the number of road users per time interval).

Accelerations and brakings (i.e., the 85th and 15th centile of accelerations) are shown in a similar way for the Coubertin site in Figure 2. The results seem even clearer for cars, with higher accelerations and especially lower brakings (larger in magnitude) after the shuttle has passed. The variability of the brakings also increases with more extreme low brakings beyond the whiskers. As for speeds, cyclists in the presence of the shuttle have higher accelerations or lower brakings. For pedestrians, the trend is a bit clearer, with slightly higher accelerations and lower brakings after the shuttle passage. This would also be consistent with a traffic calming effect of automated shuttles, as cars react less strongly in its presence, while pedestrians have to accelerate / brake more strongly after its passage when car traffic is faster and more "aggressive". The behavior of cyclists is more complicated to interpret.

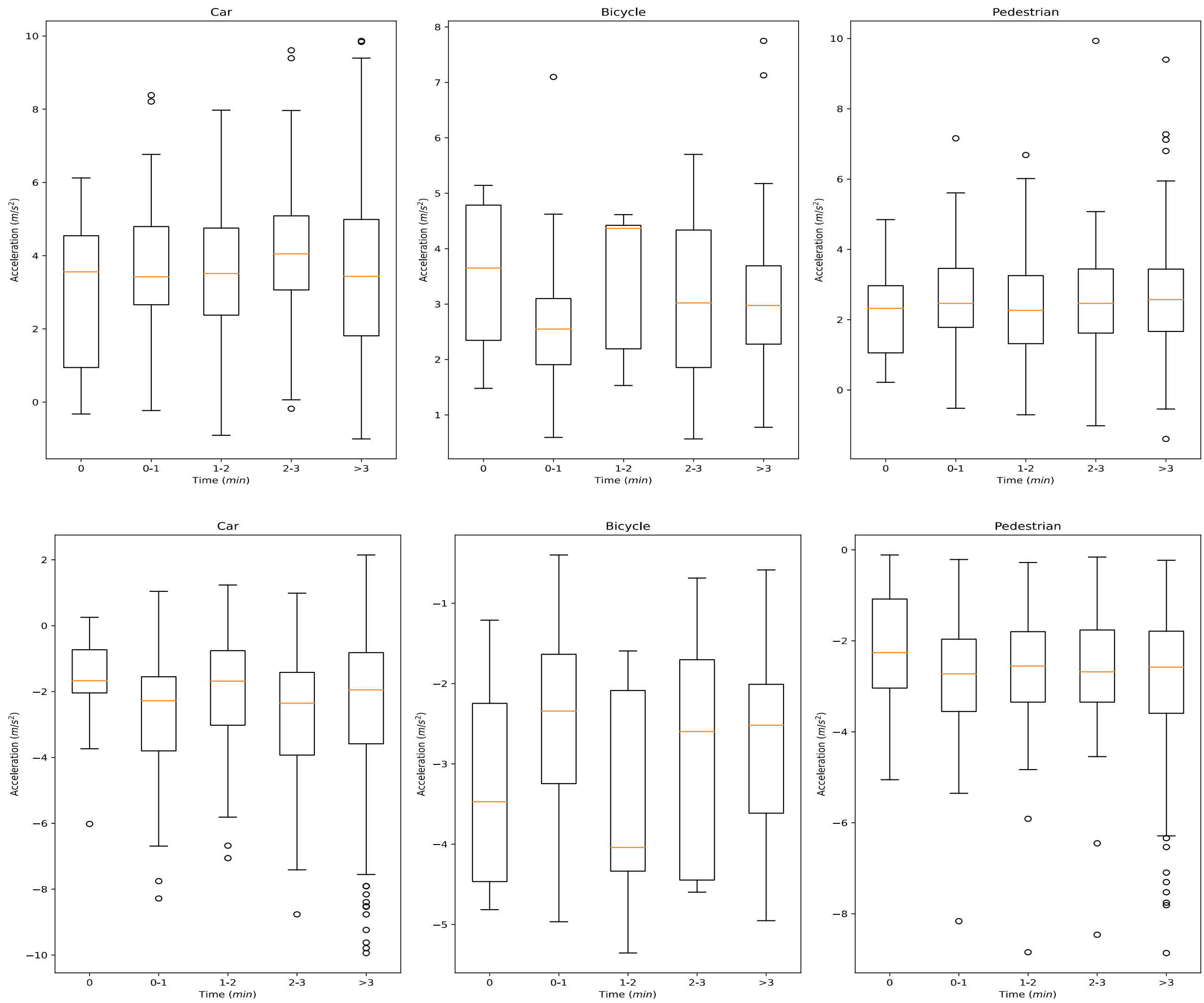

Figure 2 Boxplots of 85th and 15th centiles of acceleration (respectively top and bottom) per category of road user for different time intervals (in min) since the shuttle passed (“0” means the shuttle was present when the road user passed) at the Coubertin site.

3 CONCLUSIONS

The first results of this exploratory analysis point toward an effect of automated shuttles on the behavior of other road users, with slightly lower speeds and less harsh accelerations for cars. More analyses are needed to characterize and understand the behavior of cyclists and pedestrians, including in terms of their maneuvers and spatial distributions in the presence of the automated shuttle.

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